THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XXII.—No. 547.

OUR NATIONAL DEFENCES.

GENERAL satisfaction will be felt that a large and influential interest has been awakened on this important question. The deputation which recently waited upon the Minister for War, Mr. Stanhope, was not merely a powerful deputation, but the questions raised by its various members were questions of the gravest moment, affecting the interests of ourselves as well as our colonies. Few will feel disposed to complain of the spirit in which the deputation was received, or of the hearty and patriotic response of the War Minister. It would not, however, appear that portions of this statement are exactly in accord with recent statements made in reply to certain questions affecting the condition of our armaments. Time has again become a great factor. It would be more satisfactory to know that things once determined upon were being done, or that they were absolutely done, than that they will be in readiness at the expiration of two or three years, as the case may be. We quite incline to Mr. Stanhope's own remarks: "There is no occasion in this matter for panic"—"but there is urgent necessity for immediate action." It is this immediate action we are anxious to see. For years the question of the defence of our coaling stations and chief ports has been more or less before the country and before Parliament, and it is satisfactory to hear that this important matter is now to have practical attention. Mr. Stanhope says: "In all our military ports and at all our coaling stations, active measures for the improvement of the defences are in hand. In our leading mercantile ports every effort is being made to complete the submarine mining defences." It would, we cannot help thinking, have been very acceptable if something more definite than this, both as to the extent of these works, and to the time at which their completion might be expected, had been said. Schemes for the protection of our ports, military, naval, and commercial, have been before the Government for no inconsiderable period, and promises that they should be taken in hand have for the time quieted the public mind. Rumours of the possibility of a disturbance of the present peace of Europe are rife. We by no means aspire to the dignity of panic-mongers, but we do incline to the opinion that whether the times are peaceful or troubled, our ports and our coaling stations should be at once protected to the utmost extent by the most complete and perfect system of submarine mining it is possible to command. That this may be done in twelvemonths or two years is not enough. It should be done at once. When it is done the nation will know on what it has to depend, and to what extent it may rely upon what has been done. That provision should be made for the port of London goes without saying. London is the centre from which emanates the great bulk of our commerce; that it should be rendered, if possible, inaccessible to our enemies, is of course of the utmost importance; but in saying this it must not be forgotten that there are other points demanding equal consideration. What, we would like to ask, is being done in relation to the ports of Liverpool, Glasgow, Bristol, Plymouth, Portsmouth; for the protection of Malta, Gibraltar, &c.? London, Liverpool, the Clyde, or any of our naval seaports in the hands of an enemy would, for the time at all events, paralyse the action of any Government. Doubtless the mainstay of England will ever be her supremacy of the seas; but it will never do to regard it as impossible that a reverse will occur to our fleets. With every belief in the heroism of our sailors and in the superiority of our fleets, we shall be wise in adopting measures beyond their protective power for securing not only our chief ports, but every point which from its position may prove of strategical interest. Submarine mines will prove of untold value in effecting this, and we hope that the subject will not be allowed to drop on the mere assurance that the Government is alive to the needs of the occasion, and has it in hand. It is important, and we trust the members of the deputation which waited upon Mr. Stanhope, and who may be said to represent the feeling of the country, will, from time to time, seek information from the responsible minister in the House of Commons. Not only should active steps be taken in laying down submarine mines, but something should be done to bring more perfectly into communication one with the other, and with the various centres commanding them, all coast defences. Very little, if anything, has been done in this direction so far. The importance of such a communication cannot be overestimated. Not only should all forts, but all coast guard stations be linked together. On many parts of our coasts in times of peace such a means of communication would be of the greatest possible value to the fishing industry. Take, for instance, the coast of Cornwall during the pilchard and mackerel season. At the present time the fishermen have no means of obtaining information of the presence of these fish, which approach the coast in large shoals, the existence of which is made apparent by the colour of the water, and which may be observed some distance off, other than by posting lookouts at convenient points along the coast, who have to convey the news to the fishing convoys the best way they can. Not unfrequently does it happen that when the boats have put off the fish have disappeared, whereas had less time been occupied in conveying the information to the boats they would have taken a rich haul. Were a telegraph established along the coast it would be eminently serviceable for this, as well as for less peaceful purposes.

Another point to which we feel it our duty to direct attention is the more complete equipment with search lights, and other necessary electrical apparatus, of all

mercantile as well as naval shipping which may, should it ever happen that peace should be interrupted, be called upon to defend our interests. The employment of strong search lights would, in case of war, prove as necessary to our mercantile as to our naval cruisers, and there should be no stint in providing that which is required.

Mr. Stanhope says:—"With regard to the Royal Engineers, we have this year provided for all the necessary submarine miners for all our ports and coaling stations, and there remains only a deficiency of four companies of Fortress Engineers." We should like to know if this provides for the dispatch of any portion of the Royal Engineer Corps out of the country. What would be our position in case they were, as they have been on previous occasions, called away for the defence of our Colonies or on foreign service? Are we dependent entirely upon this corps for the formation of and for fighting these mines? It is not wise that we should be. There are others in the country quite capable of dealing with this branch of the question; and if it is probable that the Royal Engineering staff may at any time be called away, then it is most desirable the work should be entrusted to civilians, or others, whose services may be assured for the moment when they will be required. Indeed, it is not clear why, if these defences are to be laid down without loss of time, and the Royal Engineering Corps is not able to cope with all demands forthwith, advantage should not be taken of the civilian element and the work dealt with offhand. As the work has to be done, the sooner it is completed the more secure will the public feel.

IN his time Mr. Preece has played many parts and appeared in many *rôles*, but we fancy he set himself a thankless task when a week ago he appeared at the Society of Telegraph-Engineers as apologist for the new Fire Rules. As a matter of fact, the society is not with Mr. Preece and the committee; the members fail to see the necessity for fresh rules, and the contractors have to thank the council for placing fresh difficulties in their way. We have on a previous occasion expressed our opinion regarding this collection of platitudes which stitched together has been dignified with the title of "Rules," and we would say that notwithstanding Mr. Preece's apology we have seen as yet no reason for modifying it. How well the "Phœnix" rules served the end in view may be gathered from the opinion almost universally expressed that where in the new rules a change from them has been made, just to the extent of the change are the latter rendered less useful.

Mr. HEAPHY appears to feel acutely the treatment he has received at the hands of the committee, and we cannot wonder at the feeling, if only a portion of what we hear is true. "The committee and myself," says Mr. Heaphy, "were in complete accord regarding the rules, and had it not been that the word "Phœnix" appeared in conjunction with them you would never have heard of the Telegraph-Engineers Rules. You would have remained untouched by dissension, and working in accordance with the existing rules as happy as heretofore." We have heard one side of the question from the chairman of committee, and writing before the adjourned discussion is resumed, we wait patiently for Mr. Heaphy's version. He has promised to give us revelations which will put quite a different aspect on the tale already told. We admit that a set of rules which every Fire Office should recognise is very much wanted, but it is certain that this set has not been compiled by the committee of the Society of Telegraph-Engineers.

WE are strongly of opinion that self-glorification is at the bottom of this miserable squabble. Electric light engineers wanted an authoritative set of rules, and a committee was duly appointed to sit upon the subject. But, instead of grappling with the question at once, according to precedent at the Siege of Troy and elsewhere, it continued to sit and it sat until all the requisite regulations were forthcoming from another source. Now, consider the position. Here is a committee consisting of the ablest electricians of our time, a consensus of scientific eminence, philosophers, doctors, and teachers in awful majesty assembled to formulate fire rules. But fire rules are no jest, fire rules take time. Experiments must be made, complex relations must be determined. Years must elapse ere the results of its labours be seen, and while the years are merrily elapsing, behold! the questions engaging its attention are brought to a practical issue outside. Then and only then does the committee wake up, and dreadful is the awakening. The dreams of laurels won are over, but something must be done. In vain is the search for theoretical blundering made in the labours of others. Ah! that would indeed be a discovery, for is not the credit of the committee at stake? But there are no fallacies. So crestfallen and discouraged after its long and weary labours, the committee presents itself before us clad in a tattered and mutilated copy of its rival's rules, but with the word "Phœnix" torn off.

IT has been hinted at in certain quarters—and the instigators of these unjust allusions should know us better than to assume that we fear to speak our own minds—that our previous references to these rules were inspired by Mr. Musgrave Heaphy. As a matter of fact the perusal of the brochure was an all sufficient cause for our brief, but evidently well aimed comments, and as a matter of history we wish it to be known that we had neither seen nor had any communication from the gentleman who was supposed to act the Mephistopheles to our Faust for several weeks prior to this latest effusion of the Society of Telegraph Engineers and Electricians.

THE comparative values of alternating *versus* continuous current systems have been under discussion at the Chicago Electric Club. Prof. Badt read a paper which led to an interesting debate, in which several men known to us took part. The members seemed fairly divided on both sides.

IT is thankless work editing a journal in these days, and there is never wanting some one ready to prove conclusively that we are hopelessly astray in our subject. No sooner did our article of last week on "British Railways" appear than an esteemed corres-

pondent rushed into our presence prepared to prove from the tomes of Mill, Fawcett, and Spencer which he carried under his arm, that the Government never did and never could do anything economically. "Compare," he said, "the telegraphs of the Western Union Company of America with our British telegraphs, Which cost less in working? Take shipbuilding, gun-making, army-tailoring, or anything you like, and private enterprise will carry it on more profitably. Industries directly connected with the arts of war the Government cannot manage properly. Is it likely that it will be more successful with the manufactures required by the arts of peace? "Why," he continued, and here we regret to say he swore, "the Government has not mastered book-keeping yet, let alone commercial production. Let it stick to its proper function, that is protection. When it goes outside its sphere it invariably goes wrong. As for railways, may Heaven defend this radical-ridden country from State controlled railways."

MESSRS. FREDK. WALKER AND HYDE, consulting engineers and patent agents, have just conducted an experimental test of the efficiency (?) of Mr. Jarman's system of electrical traction during a trial run from Clapham to Westminster Bridge and back. The Jarman method of tramcar propulsion with its double armature motor is already known to the readers of the REVIEW. The instruments used in taking readings for the following table were an Ayrton and Perry ampèremeter, and a voltmeter, both of which were said to be accurately calibrated and checked for the occasion.

Outward Journey.

Time of starting from Clapham ...	12 h. 48 m. a.m.
Time of arrival at Westminster ...	1 h. 10 m. a.m.
Average speed (miles per hour) ...	8·43 miles.
Current at starting (level road) ...	47·0 ampères.
Mean current during journey... ...	25·5 ampères.
Mean E.M.F.	147 volts.

Return Journey.

Time of starting from Westminster ...	1 h. 33 m. a.m.
Time of arrival at Clapham	2 h. 7 m. a.m.
Average speed (miles per hour, deducting stoppages)	7·83 miles.
Current at starting on gradient of 1 in 20	69 ampères.
Mean current during journey	26·4 ampères.
Mean E.M.F.	142 volts.
Average electrical horse power ...	5·01 E.H.P.

From the foregoing figures it is evident, say Messrs. Walker and Hyde, that at least three such double journeys may be performed without recharging the accumulators, allowing a fair margin for extra weight, bad state of track, weather, &c. This we fail to see, for no reference occurs in the report as to the capacity of the cells, the time and rate of charging, or indeed of any data for which one would naturally look. The accumulators, in the opinion of these experts, may be replaced by others newly charged by two men in five minutes. There were 23 persons upon the car, the general structure of which is much heavier than that of the modern cars of the same rating now being used upon the Metropolitan lines, and the report goes on to say that the whole system has been well designed, and carried out in a practical and efficient manner; and if a charging installation for even two or more cars were laid down, there would be a distinct saving per car mile over the present cost of maintaining a sufficient number of horses to perform the same duty, and the system could be worked, even on a small scale, efficiently and profitably. It is a pity that figures are not given in support of the opinion of Messrs. Walker and Hyde, for although we have no doubt that Mr. Jarman's system is quite practicable, we cannot help expressing ourselves strongly to the effect that reports of this character are absolutely valueless from either an engineering or commercial point of view.

WE have received several letters in reference to our leaderette on the subject of demagnetising watches. One gentleman successfully arranged his own apparatus for setting his chronometer in order again, and he suggests that we should become agents for the transmission of watches left in our charge to him, when he offers to set them right. This would be a position involving too much responsibility for us to undertake. Another correspondent refers us to a recent number of the *Scientific News*, January 6th of the present year, in which an article was published on the very subject, whilst it appears that Mr. Atkinson, of Goolden & Co., has operated on quite a number of timekeepers in a semi-professional manner. Last of all, another suggests that all watches affected by magnetism should be sent direct to him for repairs. Finally, we may add that our first mention of the subject was occasioned by the visit of a gentleman who represents the watch department of the Army and Navy Stores, and who informed us that the enquiries for a means of demagnetising chronometers were very numerous. It is evident that there is room for a new field of operation in this direction.

THE motion brought by Mr. Crowther Davies before the Leamington Corporation had a curious termination, those in his favour and those against being equally divided, and as the Mayor declined to give a casting vote, the matter remains *in statu quo*. According to another account, however, the Mayor is said to have voted in favour of the light. Probably Mr. Davies, finding such unlooked for support, will again propose his motion when he sees his way clear to victory, unless something is done to convince him that no good end will result from the policy he has chosen to adopt. If our opinion carries any weight in the Leamington Town Council, we would heartily advise the members of the Corporation to support the electric lighting scheme. With a storage of electrical energy to be effected by means of secondary batteries, which should have been included as a vital part of the plant from the beginning, and a worthy resolution to make the whole installation a credit to themselves and satisfactory to the town, there appears to be no reason why Messrs Chamberlain and Hookham, who by this time must be sadder if not wiser men, should not come triumphantly out of what has been to them a most trying ordeal, and we cordially wish them success.

SCENE IN THE PATENT OFFICE.—First primary battery man—"What makes you so jovial this morning?" Second ditto—"I have just secured my patent for a new secondary battery. I would not take £50,000 for it." "Did you not get a patent last year for a primary battery for charging accumulators?" "Yes, and made £20,000 over the transaction, and now I've invented a secondary battery which the primary won't charge." "What are you going in for next?" "I shall invent a new primary battery to charge my patent secondary. I tell you, Sir, there's money in this electrical business if you only know how to work it."

ON "FLASHING" CARBON FILAMENTS AT DIFFERENT TEMPERATURES.

By LEGH S. POWELL.

(*Continued from page* 502.)

Weight and Surface.—There seems at first sight to be a striking connection between the smoothness of a filament and its weight in Experiment I. of the Second Series as the following table shows:—

Roughest surfaces	=	·00562 gramme.
Ordinary surfaces	=	·00548 „
Smoothest surfaces	=	·00530 „

It is probable, however, that this connection is only due to a further outcome of the result we have just been considering, for the roughest surfaces have likewise the lowest mean resistance, and the smooth ones the highest. The rougher surface would therefore appear to be due simply to the increased amount of flashing that these filaments had received, and the smoother ones in the same way to the smaller amount of flashing.

Weight and Time or Temperature.—There are two points which affect the time that a filament takes to flash to a given resistance. The main one is the temperature. The other will be considered under Time and Reducing; it also is a further property of flashing to proceed at an increasingly slower rate as the temperature is lowered. But in the matter we are about to discuss, viz., the connection between the weight of the filament and the time occupied in its flashing the two are but one in their effect.

It is very plain that in Series II. the slowly flashed filaments of Experiment II. weigh heavier than those of Experiment I., the average of the former being ·0057 gramme, while that of the latter is ·00548 gramme. Examination of the individual members of Experiment II. also exhibit the same tendency. Thus if we take the mean weight of all those filaments which took a longer time than the average to flash, we obtain ·00575 gramme, while the mean weight of those whose resistance fell in a shorter time than the average is ·0056 gramme.

Conversely, the mean time to flash of those filaments with weights above the average is 1 min. 35 sec., and the mean time of those with weights below the average is 1 min. 14 sec.

These are striking differences when it is taken into consideration that the temperature in each case was intended to be alike, and that disturbing influences, such as errors in adjustment, are without doubt tending to interfere more or less with the result. The figures would even indicate that the lower the temperature the greater is the rate of increase in the weight of deposited carbon for a given fall in resistance, since in this case there is a difference of ·00015 gramme, where the temperature varied within but small limits, while the difference between the two experiments is ·00022 gramme, although here the difference in temperature was enormous in comparison.

But it must not be forgotten that the mean resistance of the filaments of Experiment II. is 20 ohms higher than that of Experiment I., and that had the former been equal to the latter its weight would naturally have shown a distinct increase. If, then, the two resistances had been equal, the striking comparison between the weights at high and low temperatures, and between those produced by small differences in the temperature in the slow flashing experiment, would not appear quite so remarkable.

It must also not be forgotten that other influences are evidently at work to vary the weights besides the temperature; otherwise how is it that filament No. 5, *e.g.*, weighing ·0061 gramme, takes 1 min. 30 sec. to fall in resistance, while filament No. 15, whose weight is ·0056 gramme, takes 1 min. 40 sec.

Experiment I. does not show any internal connection between the times to flash and the weights of the filaments, and for several excellent reasons, the two principal being that the errors in adjustment are too great, as we have already seen, and the times are too short and equal. Neither does Series I. furnish us with confirmation on this point, because there is too little deposited carbon to show any appreciable differences in weight, and also for want of the times the filaments took to flash.

This property of deposited carbon to increase in weight as the temperature of flashing is decreased, proves the well known fact that such carbon varies in its specific resistance according to the temperature at which the deposit occurs. But this statement is true merely in a general sense, and under certain conditions only, as we shall see from a perusal of our next point of discussion.

Time and Reducing.—Fact six states that when filaments are flashed at a practically equal temperature, those having the lowest resistances will take the longest times to fall a fixed number of ohms in the reducing process. This seems natural enough, for the lower the resistance the greater will be the proportion which the fixed number of 20 ohms will bear. This fact is clearly demonstrated in Experiment I., where we have seen that the errors in adjustment are considerable. Thus:—

Filaments whose mean R is high, viz., 153ω, took 25 sec. to reduce.

Filaments whose mean R is average, viz., 146ω, took 31 sec. to reduce.

Filaments whose mean R is low, viz., 129ω, took 45·7 sec. to reduce.

The converse of this arrangement, viz., the comparison of the resistances with short, medium, and long periods to reduce, gives almost the same figures. Therefore, although we have only one experiment to base our conclusion upon (since in Experiment II. the errors of adjustment are very slight), still the obvious result seems very conclusively proved.

But when the temperature of flashing is different this fact is entirely obliterated, and the very opposite takes place. Thus, although the filaments of Experiment II. have a mean resistance of 20 ohms higher than those of Experiment I., still they took almost double the time to reduce which the latter required, and there is no doubt that had the two sets been of equal resistance, the more slowly flashed filaments would have taken a larger proportion of time still. It might have been reasonably expected that a connection would have been detected between the times to flash and reduce amongst the individual filaments of Experiment II. similar to that noticed between the temperature and the weight, but this we do not find. No doubt the principal reason for this is because the temperature in reducing any particular filament was slightly the reverse of what it was in the first flashing process, which would thus have altered any faint continuity in the time. This reason, however, would not interfere with the connection between the weight and the time to flash. Moreover, the unavoidable difficulty of errors in adjustment must of necessity exist, and this would also assist in destroying the expected continuity since we have just above observed that these two conditions of low temperature and high resistance are directly opposed to one another.

But where the difference of temperature in flashing is decided, and where we have to deal with averages in the reducing process, the fact is very clear. In plain words it amounts to this: If you begin flashing brightly the resistance continues to fall fairly quickly all through, but if you begin to flash slowly, then the resistance will continue to fall slowly even at an increased temperature, for it must be remembered that the temperature in the reducing process was the same in all of the experiments. It was only the temperature of flashing in coal gas which was different. The result, moreover, does not depend upon the kind of hydrocarbon compound employed in the reducing process, for a similar result would have been produced if coal gas had been finally used instead of amyl acetate vapour.

We see, therefore, that the temperature of flashing influences the weight of the filament and the time it takes to fall in resistance in a very similar manner. In the first place, at a given temperature they both increase as the resistance is lowered. In the second they both increase the lower the temperature. The law, moreover, which was indi-

cated between the temperature and the weight, in which the proportion of weight increases in a greater ratio as the temperature is lowered, is confirmed here in this matter of time to flash in a very marked manner, for we see that notwithstanding an equal temperature in this reducing process in each experiment the times are widely different.

To what, then, may we ascribe the cause of this remarkable fact? There is one thing to which this may be in some small measure attributable, and that is to the well-known fact that a thick filament takes a longer time to fall a proportional number of ohms than a thin one, since we have seen that the size and weights in Experiment II. distinctly exceed those of Experiment I. But then the difference between the two in this respect is very small, and certainly would not account for the time in the one case being double that of the other. The real cause must lie in some difference in the nature of the two surfaces, or qualities, of the carbon deposited at different temperatures, which subsequently, at the same temperature, refuses to receive a further deposit of equal specific resistance.

Resistance and Temperature.—On more than one occasion we have had to notice that there is a difference in the mean resistance cold of the mounted filaments in the respective experiments which have been made, in spite of the fact that in each series all the filaments were flashed to the same number of ohms. It is not to be expected that each individual filament when mounted should have the same resistance, but if no change occurred it is only reasonable to expect that the respective averages should agree within small limits, at any rate. But instead of agreement they show marked differences in both series, and this, moreover, in the same order, although not to the same extent. The following figures speak for themselves :—

Series I.

	Flashed to	R when mounted.
Slow flashing ...	... 415 ohms	... 361 ohms.
Ordinary flashing	... 415 „	... 356 „
Extra bright flashing	... 415 „	... 343 „

Series II.

Slow flashing ...	... 215 ohms	... 165 ohms.
Ordinary flashing	... 215 „	... 145 „

There are two main reasons why the first series shows a smaller difference than the second. One is that in the former there is a far smaller amount of deposited carbon, and the change which occurs increases, no doubt, with the quantity. The other reason is that the slow flashing experiment in Series II. was conducted at a lower temperature than its counterpart in Series I.

We may find confirmation of this alteration in resistance from internal evidence in Experiment II. of Series II., in the same manner as the connection was followed between temperature and weight. Thus, if we take the means of those filaments with highest, average, and lowest resistances, we obtain the following times :—

	Ohms.		Min.	Sec.
Mean R above average	= 170	Time to flash	1	35
Mean with an average R	= 165	Time to flash	1	26
Mean R below average	= 161	Time to flash	1	23

Conversely :—

	Min.	Sec.		Ohms.
Mean times above average	1	56	Mean R =	170
Mean of average times	1	35	Mean R =	165
Mean times below average	1	11	Mean R =	163·7

We have yet a further piece of evidence in this direction. It will be remembered that in all the experiments of the First Series the varying resistances of the mounted filaments were equalised in the reducing process. As a consequence of this we should expect to obtain in each experiment the same mean calculated resistance in the "initial" readings. But instead of this, the figure obtained for Experiment II. (the more slowly flashed) is 8 ohms higher than the other two. It is true that the incandescence is somewhat lower in this than in the other two cases, which would assist in producing the result, but it is hardly likely that the change is entirely due to this cause, for we must remember that it is 8 ohms hot and not cold. We may therefore reasonably draw from this fact one or two instructive conclusions. One is that the alteration in resistance goes on with a deposit of carbon from amyl acetate as well as from coal gas. Another that the cause of the change in resistance is not due to some unforeseen condition in the mounting process. A third that the same order is still maintained, viz., that those filaments have the highest resistance which are most slowly flashed. But we must not lose sight of the fact that these particular filaments received considerably more reducing than the other two sets, so that both quantity as well as temperature would assist in producing these results.

Let it, moreover, be noticed that the alteration in resistance is not simply manifest in the cold but also in the heated condition, as will be evident from a glance at the tables of calculated resistances hot in Series II.

From what has been pointed out there can be no doubt whatever that when filaments are flashed at different temperatures they subsequently alter in resistance unequally. It is difficult to see a cause for this. It may be due in some way to the violent change in the temperature from the incandescent condition to the ordinary temperature ; or, it may, perhaps, be due in some way to exposure to the air. But it is probably due simply and solely to the effect of time on a carbon whose resistance to the electric current is in some sort of strained and unstable condition. The slowly flashed filaments may be likened to a spring of iron wire which has been overstrained, and which on being released springs back towards its original position but only goes a portion of the way ; and, similarly, the brightly flashed filaments to lead wire, which, on being pressed and then released, only recovers its former position to a very inappreciable extent. A fuller, though perhaps not a clearer, perception of this subject will be obtained after the consideration of our next, and last, topic—the fall in resistance of the finished lamps.

Our evidence does not inform us at all clearly whether the more slowly flashed filaments rise in resistance while the ordinarily flashed remained stationary and the extra brightly flashed ones fall ; or whether they all fall or all rise in unequal proportions, according to the temperature of the flashing. But from the distinct connection between the resistance and the small differences in temperature in Experiment II., Series II., and from the continued change noticed in the calculated resistance hot in the lamps of Experiment II., Series I., it would appear very probable that the slowly flashed filaments alter the most, and this in an upward direction. If this is really the case we may, perhaps, go a step farther and point out the probability that the same law which was shadowed forth between temperature and weight, and between temperature and time—wherein the ratio increases between these respective properties as the temperature is lowered—may apply here also, and control in a similar manner the tendency to alter in resistance as the temperature is varied.

(*To be continued.*)

Central Station Lighting. — In the issue of *La Lumière Electrique* for May 12th, we notice a long article by M. W. Fritsche, on the lighting of districts from central stations. The author states that in selecting some system as a basis for his calculations, he has had resource to the method of distribution by two conductors employed in Germany, remarking that the systems adopted in America, more particularly referring to that of Edison, cannot be taken into consideration, as they are not carefully enough designed to meet the requirements of European towns. He rejects the use of accumulators on large installations, as not having attained a practical application. Diagrams are given of curves of loss of energy, of the cost of lighting with a maximum charge of 120,000 watts, and of consumption of light and of expenses, per month. Tables of cost of construction, maintenance, &c., are also given.

ON A NEW SYSTEM OF SURVEY AND CONSTRUCTION FOR RAILWAY TELEGRAPHS.

By ARTHUR E. GILBERT.

HITHERTO the practice has been for railway telegraph engineers to trust the important part of the survey of their lines to the inspector or construction foreman, who, as a rule, simply steps the distances between the poles and judges the height required for each pole by the eye; the consequence is that the heads of the poles are undulating, thereby giving a bad appearance to the line, as well as putting unnecessary upward and downward strain of the wires on each insulator or support.

From my experience with outside telegraphs I have thought it high time some standard mode of survey should be adopted, as such is the backbone of a telegraph line, and I therefore write this article, incomplete as it may be, for the benefit of those engineers who are building—or, rather, endeavouring to build—their lines to withstand the vicissitudes of the weather.

The first operation is to chain the section and paint the number of each pole on the end of the sleeper or fence-post, and also a paint mark on the web of the rail, the latter being the proper distance for the pole, as the former is apt to get obliterated in the course of time.

If the number should be, say, 101 or 102, it is unnecessary to paint the three figures, but simply 1 or 2, and so on up to 0.

These numbers will be found of great assistance to the construction foreman in finding the position and

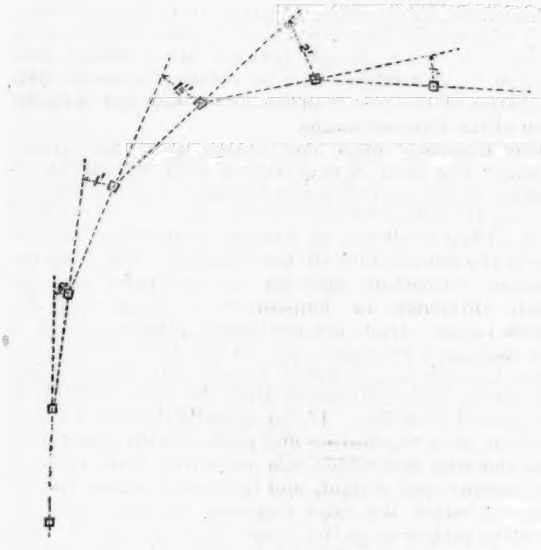


FIG. 1.

erecting the proper length of pole as recorded in the survey-book, and which numbers could hardly be dispensed with on the barren sections of a railway.

After the section has been chained, the surveyor returns to the starting point and commences pegging and recording the angles, fig. 1, the latter being taken with a tape, level crossings, bridges, mounds, and the

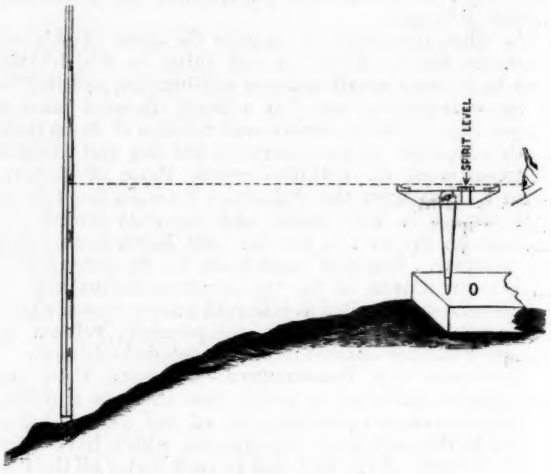


FIG. 2.

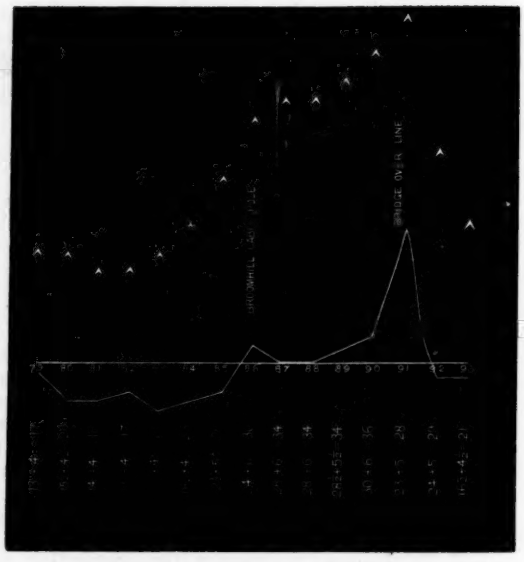


FIG. 3.

nature of the pole required, whether a double or a single pole, after which he takes the levels, fig. 2, on the return journey.

This completes the survey, and all that now remains to be done is to make a drawing, fig. 3, to get the

FIG. 4.—*Section Surveyed, Dava to Grantown; Date, August 24th*, 1886.

No. of pole.	Distance in yards.	Length of pole.	Depth of hole.	Length of strut.	Description of pole and position of stays.	Level of ground. Rise.	Level of ground. Fall.	Angle in feet. <	Angle in feet. >	Remarks.
0	...	26′	4½′	...		...	...	...	...	*Office terminal pole.*
1	60	18′	4′	...	½	12′	...	...	...	*Main line terminal pole.*
2	60	20′	4′	...	½ „	9½′	...	10′	...	*Behind tank.*
3	60	19′	4½′	...	½ „	10′	...	10	...	
4	60	18′	4	...	½ „	8½′	...	9	...	
5	60	20′	4	...	½ „	2½′	...	8	...	*Drain under lines.*
6	60	20′	3½′	...	½ „	...	1′	8	...	*Cabin.*
7	60	20′	3½′	...	½ „	...	2′	9	...	

Signature of Surveyor, A. E. G.

proper lengths of the poles for entering in the survey-book.

When the ground is higher than the rail level the surveyor and his assistant change places, the level being taken by driving the spike of the levelling instrument into the top of the survey peg, instead of the sleeper.

My object in recommending this system of survey will no doubt be obvious, and the manner in which the same is recorded, fig. 4, is essential for a properly constructed line of telegraph.

There could be no better base to level from than the rails—or, rather, the sleepers—and the arrangement being so simple and sure it enables you to save a lot of timber throughout the line.

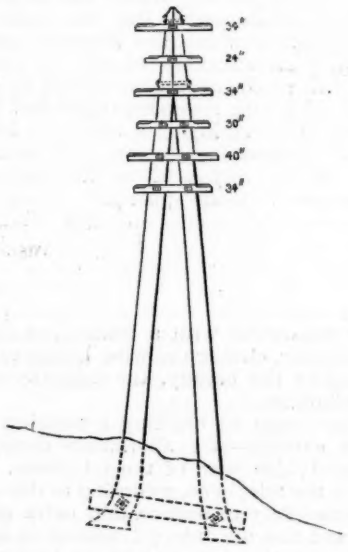


FIG. 5.

Two miles per day over curvey and and hilly ground is good work to survey and level, and 3 to 4 miles may be done over straight and flat ground, but if mistakes are to be avoided the survey should not be hurried.

The number of men employed in the survey is as follows, viz. :—

Chaining the Section.

Surveyor	1
Chainers	2 including construction foreman.
Peg carriers	2 drop a peg at each paint mark.
Painter	1
Total	6

Pegging the Section.

Surveyor	1
Construction foreman	1
Stick carriers	4
Peg driver and hole marker	1
Total	6

Levelling the Section.

Surveyor	1
Levelling stick carrier	1
Total	2

Tools.

6 Round iron pointed sticks, 7 feet long, and painted white with red top.
1 Levelling stick, 14 feet long, and pointed.
1 Spade.
1 Axe.
1 Tape.
1 Levelling instrument.
1 Can white paint.
1 Brush.
100 Survey pegs.

The survey pegs being only 6″ × 1½″ × 1½″, have a hole by which a large number can be threaded on a piece of No. 16 wire and slung over the shoulder, as this is found preferable to carrying them loosely.

It is advisable not to disturb the survey pegs when digging the holes and erecting the poles, as they are useful as a check on the construction. The manner of measuring the depth of the holes is shown by fig. 6.

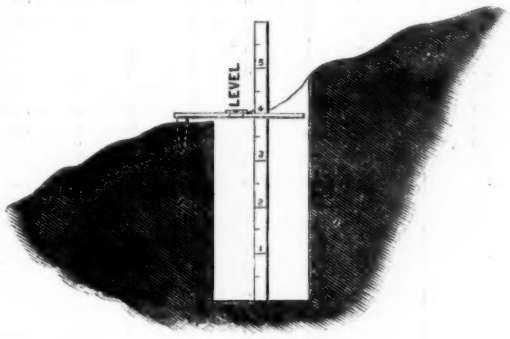


FIG. 6.

I employ double poles up to 30 feet in length, except in special cases, fitted together in the form of an inverted V, fig. 5, on straights and slight curves, and single poles with stay and rod on sharp curves, as the expense of the former is, if anything, cheaper and decidedly stronger to double staying. Only one hole is required for a Λ-pole in place of three holes for a single pole with double stays, and as the stays can never in practice be properly kept taut, they dangle about, and, in fact, do more harm than good in a storm.

I also employ a draw strut in line with the wires on every 10 or 12 poles (the old timber often answers for this purpose) to prevent the wires running back beyond that distance should they snap or give way under the weight of snow or from other causes.

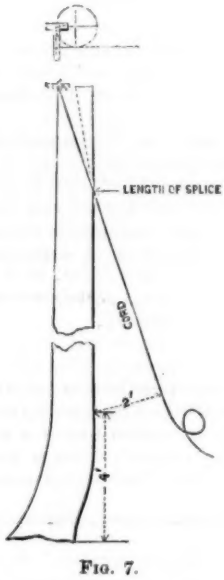


FIG. 7.

Fig. 7 shows the mode of measuring for the splice of the Λ-poles, and as the the splices vary in accordance with the lengths of the poles, a table is necessary, fig. 8.

Pole arms should not be less than 12 inches apart to avoid risk of contacts by the wires sagging under the weight of snow.

An arm setter is a most necessary tool in the construction for setting the arms at right angles to the wires (*vide* the REVIEW of 6th April), as also a plumb

FIG. 8.

Lengths of poles.	Space inside legs.		Distance from butt.	
	Feet.	Inches.	Feet.	Inches.
16	2	...	3	6
17	2	...	4	...
18	2	...	4	...
19	2	...	4	...
20	2	...	4	...
21	2	1	4	...
22	2	2	4	...
23	2	3	4	...
24	2	4	4	...
25	2	5	4	...
26	2	6	4	...
27	2	7	4	...
28	2	8	4	...
29	2	9	5	...
30	2	10	5	...
31	2	11	5	...
32	3	...	5	...
33	3	1	5	...
34	3	2	5	...
35	3	3	5	...
36	3	4	5	...
37	3	5	5	...
38	3	6	5	...
39	3	7	6	...
40	3	8	6	...

in the setting of the poles, and to give them their proper lean or shoulder against the strain of the wires.

The insulation of long and important circuits can be greatly improved by binding the wires on the loop principle, fig. 9,* at every alternate pole, but this only

FIG. 9.

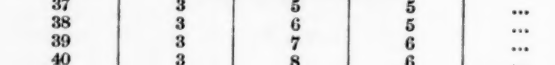
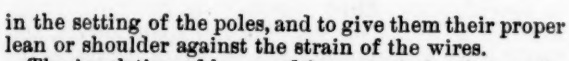


FIG. 10.



applies to straights and slight curves. Other wires on straights should be bound inside and outside, fig. 10, to lessen friction and pull on the binders in stormy weather.

I cannot help thinking and remarking that the construction, and especially the survey of our telegraphs, has been a neglected subject, and that if our chief men aroused themselves and turned out and devoted their minds as much to the practical details as they do to the theoretical, we should possess a substantial system of aerial telegraphs, with the result that breakdowns, instead of being of common occurrence as they are now, would be rare and forgotten.

I may mention in conclusion that I survey for the telegraphs of my company. The time occupied is well repaid, and after such has been worked out and recorded the foreman has all the engineering details before him, and I must say it is a relief to know and feel that your lines are being constructed on a principle that will resist any storm likely to bear upon them.

Engines for driving Dynamos.—Some very long runs have been made with the Westinghouse engine used for driving dynamos in America. Some little time since, one of these engines was said to have run for 11 months at a speed of 300 revolutions without a stop. This has however, been beaten by another engine of the same type of 10 H.P., which has now run for upward of 13 months without stopping, at a speed of 500 revolutions per minute. Why is not the Westinghouse engine employed more largely in this country.

* *Vide* the REVIEW of 31st December, 1886, and *Engineering* of 1st April, 1887.

THE MEASUREMENT BY THE TELEPHONE OF RESISTANCES NOT FREE FROM INDUCTION.

IT has been repeatedly asserted that resistances of conductors, according to Wheatstone's bridge method, can only be effected by means of the telephone if they are free from self-induction. But as such resistances are rare in electrotechnical practice, writes Josef Popper, in *Zeitschrift für Electrotechnik*, whilst relay bobbins, wrappings of dynamos and wire coils, as met with in trade, have to be frequently tested for resistance, the chief sphere for the employment of the telephone as a measuring instrument would cease to exist if this assertion is correct.

For about two years the author has measured with the telephone, resistances not free from induction, in a very satisfactory manner. The accuracy was as great as that with a galvanometer which was fairly astatic and fitted with 7—800 coils of wire, and relay bobbins were measured having resistances of 80 and 170 ohms.

Of course, when employing a telephone for the null methods, we necessarily occasion alternating currents, produced, *e.g.*, by means of an inductorium or an electro-magnetic rotatory apparatus. Consequently it is necessary that a resistance with self-induction introduced into the Wheatstone bridge causes an extra current, which makes the silence of the telephone, and consequently the entire null method impossible. But if we proceed in the same manner as it is done in measuring resistances with a continuous current and the galvanometer, closing the wire bridge of the latter subsequently to the battery, the difficulty ceases also with the telephone.

The author uses an ordinary measuring battery—continuous current—and alternately closes and interrupts the bridge wire of the telephone. Hence it is plain that the telephone, according to this method, is brought completely to silence, that extra currents do not occur, and that the internal process is as follows: so long as the slider is not in its proper place an extra current will be perceived in the telephone, since the total resistance of the system is modified in consequence of closing and opening the bridge wire. This extra current does not, however, interfere with the measurement, since in this position there is always a bridge current. As the slider is brought continually nearer to the right position, the bridge current becomes constantly weaker, and therefore also the extra current, since the influence of the bridge wire upon the whole system grows less. When the right point is reached the bridge wire has no longer any influence, and the telephone remains mute.

The advantages of the measuring telephone as compared with the galvanometer are simplicity, less liability to breakage, portability, cheapness, non-sensibility to changes of its constants and to external magnets and masses of iron. On the other hand, it does not admit of such accurate determinations, and is not easily applicable among noises.

NOTES ON ELECTRICAL AMERICA.

By J. SWINBURNE and R. P. SELLON.

WE have often felt how amused Americans must feel at the way English people go over to the States, travel about for a few days, and then write a book on America. It does not require any special qualifications to enable anyone to write a book on America. Anyone whose name is well known, for instance, a novelist, an eminent lawyer, a fashionable preacher, an actor, a literary critic, or a popular journalist, is perfectly competent to write a comprehensive work which may deal with the whole subject exhaustively in anything between ten pages and one volume. Remembering this, we feel that in limiting ourselves to a few notes on electric lighting in America we are guilty of a degree of modesty unparalleled in the annals of the Britisher.

Our mission to the States was a search after truth. We went to obtain evidence on commission from Mr. Brush relative to the compound-winding patent, which is well known to most readers. The writer had to cross-examine. The search after truth was on his part.

We went to Cleveland by Pittsburgh. As this is not a treatise on America it is not necessary to go into raptures over the scenery, or to describe the unheard of wonders of a Pullman train, with dining, smoking and drawing room cars. (Pittsburgh is best known to electricians as being built round the Westinghouse works.) The Westinghouse Electric Company are working night and day, the works being much too small for the present demand. The dynamos and transformers are so well-known in this country through the American electrical papers, and quotations in the English journals, that they need not be described. Mention must be made of several points in connection with them. In the first place they run their machines very much faster than we do. A machine with an armature 15 inches in diameter by about 18 inches long is run at 1,650 revolutions per minute. Now, in England, we run such a machine at 800, and the advocates of slow speeds reduce it to 400. Which practice is right? If such machines can be run safely for months and months day and night at 1,650, surely it is absurd to limit them to 800, or a quarter of the centrifugal force, and still more ridiculous to cut us down to 400. It must be remembered, however, that the Americans do not as a rule get a large output from a small machine. So that the torque is much smaller for an armature of given size. This difference in practice may be due to their not going so carefully into what we call scientific design of dynamos, or it may be that the demand for plant is so large that the time is not yet come for cutting down the size of dynamos to the closest limit, or it may be that we are too apt to think a scientifically designed machine is cheap because it is small, while in reality the American machines are the cheapest because they take less labour. Of course a dynamo is not actually as cheap in America as in England, but it is possible that where labour is very dear, a dynamo which has a lot of material but needs little labour in construction is cheapest. The Westinghouse dynamos, like all the American electric light machines, are very well put together and beautifully finished. The Westinghouse Company run their machines very much hotter than we do. They are so hot that the hand cannot be borne even on the framework. Here again, perhaps, we may learn something. At first, people will of course say that shows bad design, but does it? If machines can be run for any length of time, at say 200° F., without coming to grief, surely we are in the wrong if we waste money in making them run at 100° F. The prejudice in favour of low temperature probably originated with Admiralty inspectors, who are also responsible for the prevalence of slow speeds in this country. Of course if such high temperatures as 200° F. injured the insulation they should be avoided, but we have no reason to suppose they will do so. The cleading of a locomotive boiler withstands a much higher temperature year after year. Engineers must remember that running machines at low temperatures and slow speeds simply means making the machines too large for their work, and this increases the cost of electric lighting, and helps to retard its development in this country.

The Westinghouse transformers are too well-known by description in this country to need more. The sheets of iron both in the transformers and in the armature cores of the dynamo are exceedingly thin. They are insulated one from another by thin paper.

The Westinghouse Company are making very large numbers of lamps. They are made with moulded bulbs, which are so well finished that they look as if they had been carefully blown from tube. The manufacture is very rough and ready from an English point of view, but the lamps are sold in large quantities, and at a lower price than here. Probably, as competition becomes keener in the States, more care will be taken in the manufacture of the lamps.

There is a great deal of central station lighting in Pittsburgh. It is done by Westinghouse machines and Westinghouse transformers. At first the dynamos were driven by large Corliss engines, but it was soon found that that was a mistake, and a number of small high-speed engines are preferred. Almost the first thing we noticed in American stations was the absence of skilled labour and the rough-and-ready arrangements. It must not be supposed that there is anything makeshift, but they seem to run an installation without any skilled labour and without any accurate instruments or other refinements; and they make it work, and work well. They measure, or pretend to measure, alternating currents—for instance, by means of solenoid and core instruments, whose readings have in reality no definite relation to anything. Generally they tell when their E.M.F. is right by the power of the human eye, a practice unfortunately only too common in England. Their switch-boards and apparatus of that sort look more practical than ours. The brasswork is left rough from the foundry, or bronzed, except at the working contacts. Whether this really saves much money may be doubtful, but certainly our elaborate and ponderous switch-boards covered with polished and lacquered brass and copper work seem to involve unnecessary expense.

The large Westinghouse incandescent lamps are quite a feature in Pittsburgh; hotel dining-rooms, for instance, are lighted by a few huge lamps. Lamps of this size are now being introduced by Messrs. Clarke, Chapman & Co., and others, on this side of the water, but they are quite common in the States.

We must not leave Pittsburgh without mentioning the natural gas. This is drawn from the ground at high pressure some distance from the town, and is brought in by pipes and used under boilers, and wherever coal can be replaced by it. Boilers are self-stoking, for a valve is arranged which is controlled by the steam in the boiler, so that if the pressure rises the gas is shut off. We asked the power of one of the Corliss engines at one of the stations. We were told they did not know. We said, "Is it not important to take indicator diagrams to see that your engine is running with proper economy?" "We know it don't amount to anything in the expenses of the station." "But it must make a difference in your fuel account; how are you charged for gas?" "We rent a 5 inch pipe."

Natural gas is used wholesale throughout the district. It cannot be used for lighting with ordinary burners, as it is not rich enough. Streets are lighted with it, however, by letting it stream out of the open pipe so as to make a great flare. Some of these gas torches have flames about 5 feet high. Natural gas, though generally supposed to be an American production, is really quite common in this country. It is not used for physical or moral illuminating purposes, but is expended lavishly in political speeches and in exploiting primary batteries.

From Pittsburgh we went on to Cleveland, our business being there. Legal business, at any rate as far as taking evidence on commission is concerned, is carried on in a very free and easy way. The examination of Mr. Brush was a very slow affair. During the whole time people kept straying in and telling yarns. The witness sat at one end of a table leaning back in his chair with one leg on the table, smoking. Almost everybody smoked. A few preferred to take the weed in a less ornamental manner. When you asked the witness a particularly telling question, he would as likely as not say, "Hold on a bit. Say, Ricks, what was that you was telling Sherman?" "Oh, a man meeting a friend said, 'Hullo, where have you been for a week back?' 'Have not been anywhere for a weak back, my back's as strong as yours is.'" Or, for instance, when Mr. Sellon asked the witness, referring to a letter dated 1822, "Did you write this letter in 1882?" "No, sir, I wrote it yesterday, and have worn it in my boot ever since to make it look old."

We asked Mr. Davis, our "stenographer," to take down the proceedings *verbatim* for half an hour, and as he is one of the leading reporters in the district, he

was able to do so in spite of several sets of yarns going on at once.

. . . . . .

Mr. SELLON: Doctor, do you think I could lay hold upon a pen?

Mr. STOCKLEY: He wants a quill pen.

Mr. SWINBURNE: All legal people in England write with quill pens.

Mr. STOCKLEY: What do the illegal people write with?

Mr. SWINBURNE: Oh, we haven't any in our country. We come over to America to see them.

Mr. BRUSH: Why do you make the distinction?

Mr. STOCKLEY: They send them all over here, do they?

Mr. SWINBURNE: Yes.

Mr. BRUSH: "Caught you there, didn't he?"

Mr. BRUSH, after a pause: "He has just caught on. It has just hit him."

After further talk in reference to some exhibits and the manner of offering them,

Mr. SWINBURNE asked Mr. Brush: "Does your company supply any lying circulars?"

Mr. BRUSH responded: "No."

Mr. SWINBURNE: Because we have an order calling for any circulars you may have.

Mr. BRUSH: No; we read those in the foreign electrical papers. They satisfy our appetites.

Mr. SWINBURNE: You have none in this country?

Mr. BRUSH: No.

Mr. SWINBURNE: Have you any circulars that you consider truthful in this country?

Mr. BRUSH: That is a leading question.

. . . . . .

Mr. BRUSH: I suppose Mr. Swinburne now is loaded to the muzzle.

Mr. SELLON: Dangerous to dogs, fleas and horses.

Cross-examination.

(A few legal questions cut out.)

Q. It means that the object is to maintain some field—not any definite field?

A. Is that a question? That is not a question; that is a statement.

Q. I said a note of interrogation.

A. Sherman, your man here is at the helm. You want to wake up now and help him.

Mr. SHERMAN: I am watching him very closely.

Mr. BRUSH: Do you English put your questions that way?

Mr. SWINBURNE: You see, in a court of law in England you can tell by a man's tone. I forgot that it looked funny on paper.

Mr. BRUSH: It looks funny on paper.

Mr. SWINBURNE: Yes. I am altering all my questions—translating them into English as I go along—into American English.

Mr. BRUSH: Yes, not Choctaw.

Q. Though the object desired is attained by a constant potential machine, constant potential is not disclosed at the foot of page 10, is it?

At this point in the examination Major W. F. Goodspeed, United States Marshall for the Northern District of Ohio, entered the room, and the witness saluted him thus: "How are you, old fellow?"

Captain RICKS, the Commissioner, introduced Major Goodspeed, saying, "This is the Lord High Chancellor of this Court. That is the way he goes round, with a cigar in his mouth and his hat on?"

Major GOODSPEED: There is no dignity about this court, is there, Sherman?

Mr. SHERMAN: Not much.

Mr. BRUSH: Major, these English gentlemen, I suppose, are accustomed to see a judge sitting up on a bench with a nightgown on and a horsehair door mat, and a whole lot of that stuff, looking as solemn as though he knew something.

Major GOODSPEED: You have heard the story they used to tell on Critchfield, down in Holmes county. He was around electioneering and he stopped at a farmhouse out four or five miles from Millersburgh. The men of the house were out, but the old lady was at home, and, telling of his visit afterwards, she said she liked Mr. Critchfield, he was "so so-ci-à-ble." She said, "He pulled his chair up, put his feet on the mantel and spit right in the buckwheat batter, and was just as so-ci-à-ble as he could be."

Mr. BRUSH: I can see Captain Ricks is getting ashamed of this court.

Captain RICKS: Say, Goodspeed, sit down and tell us about your experience as president of a court martial.

Major GOODSPEED: During the war I was president of a court martial appointed to try an old fellow, an artilleryman. We were all artillerymen, and young fellows. I was president of the court, and I did not know anything about law, nor did any of the rest. And this old fellow was a preacher that belonged to Bridge's battery, an Illinois battery, and he lived in Springfield. He had been a preacher, and lawyer, and everything in the world—one of these smart fellows—smart as lightning, but he was not very well balanced. He was enlisted in an Illinois battery, and he knew personally the President of the United States, Mr. Lincoln. He claimed that he was fraudulently enlisted after he had got down there and served a year or two, and instead of sending his papers up through the proper channels, he wrote direct to the President. The President sent the matter over to Mr. Stanton, the Secretary of War, to have it investigated, and Stanton ordered the old fellow court martialled for not sending his papers up through the proper channel. Well, I was appointed president of the court martial, and, as I said, I did not know much about law, and the judge advocate did not know much more than I did, and this fellow would tie us all up with his law questions. We tried him at Atlanta for a while, and then we had to get out of Atlanta, and we moved up to Gaylesville, Alabama, and every time we stopped a day or two we convened the court to continue the case. He got us all mixed up. We finally got round to Pulaski, Tennessee, and we held the court in a church. I was away up in the pulpit, and the other fellows were sitting down below, the prisoner out here in the Amen box. Well, sir, we tried him there as long as we remained there. To show what a dignified court it was, we had a Dutchman, a captain of a Pennsylvania battery, as a member. And whenever anybody objected to a question—I didn't know whether it was right or not—whenever anybody objected we would clean out the court, and then decide whether the question could be asked or not. Well, we had not been going on more than 15 or 20 minutes that day before this Dutchman said, "I object."

"Well," I said, "What is the matter with you, now? That don't amount to anything."

But he insisted on his objection, and so we cleaned out the court, all but the members of the court.

"Now," he said, "the reason I objected, I thought it was about time for the court to take a drink."

So he pulled out a canteen of whisky, and the court all took a drink; and then he withdrew his objection, and we went on. Well, sir, we kept trying that old fellow while we were at Pulaski, and finally Hood came up there, and we had to get out; and while we were on the march the old fellow lay down in a fence corner, and the rebels captured him, and that busted the court. It has not adjourned, it is in session yet I expect.

Dr. LEGGETT: The case is still pending?

Major GOODSPEED: I suppose so. I never was so glad in my life as I was when I heard that that old fellow was captured. I expect if the war had lasted 15 years, we would have been trying him till it ended.

THE VAN RYSSELBERGHE SYSTEM IN SWITZERLAND.

DR. ROTHEN, co-director of the Swiss telegraphs, writes to the *Journal Télégraphique*, of Berne, as follows:—

"In Switzerland we have been obliged to give up the Van Rysselberghe system between Geneva and Lausanne, and construct a special telephonic line. We are also compelled to abandon the system between Bâle and Zurich; the independent telephonic line is already laid out, and will be constructed as early as the season permits."

Dr. Rothen further writes:—"The Rysselberghe system has certain weak points. The apparatus is especially delicate, especially the condensers. A relatively slight atmospheric discharge may destroy them completely. It has therefore been necessary to apply lightning rods which can transmit the atmospheric discharges more easily than the condensers; but then these rods easily become deranged, as a slight atmospheric discharge may put the telegraphic line in communication with the earth, and, in spite of the great sensitiveness of the lightning-rods, the condensers are sometimes destroyed. The Rysselberghe system affects the telegraphic service in an annoying manner. At the outset it is necessary to increase the batteries of the telegraphic stations considerably; but a worse point is that the telegraphic service is delayed by the increased duration of the variable state of the currents. The Morse service generally does not suffer, but the transmission on the Hughes system is often deranged, and the service of the rapid apparatus, such as the Wheatstone, is probably impossible.

"From a telephonic point of view, the transmissions are very faint, at least with ordinary apparatus, and the silence of the telegraphic signals is, so to speak, obtained only in theory.

"The costs of the installation of the system are not so trifling as it is sometimes believed. Its application on the telegraphic line from Geneva to Lausanne cost about 15,000 francs."

ELECTRIC LIGHTING AT EXETER.

ON Friday, at the Exeter Town Council, a letter was read from Mr. H. W. Michelmore, secretary of the local electric light company, asking for permission to carry wires across the streets of the city for the purpose of lighting private houses and shops with electricity. It was proposed to carry the wires on iron poles in the line of the kerb about 20 to 30 feet high.

Alderman DAW inquired what was the present position of the company in question. Was it registered or in process of registration, of whom did it consist, and how many shares had been taken up? He asked these questions in order that the council might know whether or not they were treating with a substantial company.

Alderman ELLIS inquired whether those were proper questions for the representative of the gas company to ask, to which Alderman Daw replied that he was there simply as an alderman, and the imputation should be withdrawn.

The MAYOR observed that any such imputation was to be deprecated, and with regard to the questions submitted said that the way to get at the facts was to ask the secretary for further information.

Mr. FULFORD moved, and Mr. WARD seconded, that the secretary of the company should be asked to provide the council with the necessary information.

Alderman DAW said the whole essence of the question was whether the company was registered, and that information might be given by the chairman or several directors of the company who were present.

The MAYOR stated, for the information of the council, that the certificate of the registration of the company had been in his office for the past two months. Alderman Daw would know as a lawyer that no company could issue a prospectus unless it were registered.

Alderman DAW replied that a company might consist of seven shareholders of £1 each.

Mr. TOWNSEND contended that first of all the question of overhead wires should be considered.

Alderman ELLIS said that the electric light company was not only formed, registered, and started, but the shares were being freely subscribed. There was no question that the company would be of a substantial character, and was likely to satisfactorily fulfil its purpose. If the necessary permission for erecting wires were granted, the company would be able to provide for a want which was much felt.

Alderman DAW denied appearing as solicitor to the gas company. He was a large shareholder in the latter, and did not fear the electric lighting company. He should carefully abstain from any vote on the question, and he trusted the directors and shareholders of the electric light company would do the same.

Alderman ELLIS, speaking for the directors of the electric light company, said that they would do nothing whatever to prejudice the action of the Town Council.

Mr. BLACKBURN pointed out that Mr. H. G. Massingham had already spent £1,000 in endeavouring to demonstrate what could be done with the electric light. The company intended to work in connection with water power, by which means £1,800 in coal and similar expenses would be saved. The council had a memorial from 3,000 citizens asking them to consider the question, and he did not think they ought to stand in the way of progress. Plans had been completed for the works and for the laying down of turbines at Trew's weir.

Eventually an amendment, moved by Mr. TOWNSEND, was carried with only six dissentients, to the effect that the letter should be referred to the Streets Committee with instructions to report on the principle of overhead wires being permitted or not within the city.

KENSINGTON COURT ELECTRIC LIGHTING.

THE central station of the Kensington Court Electric Lighting Company, which during the past year has successfully supplied the residences on the Kensington Court Estate, is about to have its plant doubled to meet the requirements of the neighbourhood. At present there are two engines and dynamos and the necessary accumulators, but after the new plant is put in there will be provision for supplying 4,000 incandescent lamps continuously, or some 6,000 in all. The installations will then be transformed into a complete three-wire system of supply. Eventually it is intended to locate accumulators at points from 600 to 900 yards distant from the generating station—one to the northward for feeding the large houses at the north end of Palace Gardens and the adjacent buildings in Bayswater Road, another near the Kensington Town Hall, and a third to the south-east of the generating station at a point not yet determined. At present the central station supplies a neighbouring district whose extreme limits so far are 900 yards to the north and 600 yards to the south-east. The use of local accumulators will materially extend the area of lighting. The plant has been provided by Messrs. R. E. Crompton & Co., of Chelmsford, and 4, Queen Victoria Street, E.C., and consists at present of two combined steam engines and dynamos of the Willans-Crompton type. The engines can indicate 45 horse-power, and the dynamos charge, during each afternoon and evening, a Howell accumulator. Each cell of the latter has 35 plates, and can, it is stated, be discharged with great rapidity without injury to itself. This is an advantage in meeting a sudden call for electricity or draft upon the resources of the station. The accumulator receives from the dynamos a sufficient charge to keep up a continuous supply of current day and night, so that the light can be had at any time when required. The undertakers reserve the right to stop the supply under certain conditions, by day, for operative purposes if necessary, but this privilege is one which need seldom be exercised. As a matter of fact, during the past year the light has been kept on continuously like gaslight. The difference of potentials adopted is 102 volts, and the lamps, which are of the Edison-Swan pattern, take 33 watts for a light of 10 to 12 candle-power. Mr. Crompton finds a lamp of this power very convenient for lighting private houses. It is quite sufficient for any ordinary table, passage, or bedroom service, and it is only in very large rooms or for large dining tables that a larger lamp of 22 candle-power, taking 66 watts, is employed. The two engines and dynamos at present installed supply 600 ampères, which is equivalent to about 1,800 of the ordinary lamps used—that is to say, the 10 to 12 candle lamp. The mains have been laid in three different manners—namely, cables of the Callender and other sorts drawn through 6 inch cast-iron pipes, or laid in bitumen casing, and bare copper conductor laid in a brickwork and cemented culvert having a concrete bottom, and running under the footway. The culvert is divided into two channels by a mid-feather of brickwork in cement, and the whole is covered with substantial flagstones. Where it passes under asphalte it is, in addition, covered with a layer of concrete. Under a flagstone pavement this is not considered necessary. In the longitudinal channels thus formed the copper conductors are strained over porcelain insulators standing on short iron uprights fixed to the bottom of the channel, and the straining is effected by screw shackles, which, by putting the conductor in tension, reduce the number of insulators required. There is a movable flag over the insulators to give access to them for inspection, and care is taken to keep the culverts properly drained and to prevent the entrance of vermin. The insulation thus obtained has been very perfect, and no trouble has resulted so far from moisture. In fact, the insulation is practically as perfect as that got by using the best continuously insulated conductors, and their cost, as stated by Mr. Crompton, is considerably lower. Moreover, this form offers great facilities for attaching the branch conductors to the houses on the route, a movable flagstone being placed opposite every other house. The current is charged for by the indications of electric meters fixed in the basement of the consumers' houses, at the rate of 8d. per Board of Trade unit. This makes a lamp of 10 to 12 candle-power cost ·28d. per hour. At this rate a residence can be supplied for about the same cost as that originally paid for lighting by gas, oil, and candles, and the electric light consumer doubtless saves upon the cost of cleaning and the duration of the decorations.—*Times.*

INCANDESCENT LAMP PATENTS.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.* HOLLAND AND OTHERS.

(*Before* Mr. JUSTICE KAY.)

(*Continued from page* 519.)

THURSDAY, MAY 10TH.

Mr. A. W. HEAVISIDE, continuing his evidence, said: In the lamps I saw the carbons were of two kinds. With one kind the light was even, while in the other, looking from one angle, the line of light appeared to be thinner than when regarding it from the right angle. I tested Mr. Swan's lamps on several occasions prior to November, 1879, frequently in presence of friends of his and of my own. At least one of my staff was always present when the experiments were made. When the tests were first made, I had loose wires run from the various batteries to the point where we placed the lamp. These loose wires were very inconvenient for making changes in the arrangements of the batteries, therefore I had a simple test box put up to enable the tests to be made more conveniently. This test box was put up prior to November 15th, 1879. One of Mr. Swan's staff lived at Whitley, where I lived, and we travelled occasionally together; the small assistance I was able to render Mr. Swan with his incandescent lamp was a subject of conversation between us. I know that this was prior to November, 1879, because Mr. Mayfield, the gentleman of whom I speak, left the neighbourhood in 1879. Quite early in the autumn of 1879 Mr. Mayfield came to my office and borrowed for Mr. Swan a Wheatstone bridge for the purpose of testing the resistance of his lamps. The lamps run from batteries at the Post Office burnt variously, some satisfactorily, others not so. I saw the lamps at Mr. Swan's place in Moseley Street on several occasions; to the best of my ability I saw them alight there, but about that am not quite clear. I believe that I saw about ten or a dozen lamps upon one occasion. Mr. Swan did not say anything about treating these communications as confidential, nor did it seem to be necessary, for it was a matter of general conversation in the Chemical Society as to the proceed-

ings of Mr. Swan. Subsequently to 1879 I was led to think that certain matters were confidential, by Mr. Swan asking me if a certain man could be trusted.

Cross-examined by the ATTORNEY-GENERAL: I was never paid by Mr. Swan for anything I did for him. The only type of lamp I remember seeing contained a horseshoe filament. I continued to work for Mr. Swan during the greater part of 1880. Without careful examination of my private notebook at Newcastle, I cannot state the earliest date at which I assisted Mr. Swan. Some of the lamps I saw at Mr. Swan's in 1880 had a second turn of the coil; I am not sure whether I saw any such before December, 1879. In 1879 I knew nothing whatever about the manufacture of the lamp. I had heard the name of Mr. Stearn, but was not aware that he was working for Mr. Swan. I understood from Mr. Swan that his carbons were made of parchmentised paper in some form or other. The maximum pressure put on the lamps in 1879 was 120 volts. I did not know at the end of 1879 that Mr. Swan was hoping to patent an incandescent lamp. I do not know the date at which Mr. Swan discovered the thread lamp; I believe he brought it to me early in 1880. I tested it, and found its resistance greater than that of earlier forms. I have no recollection of Mr. Swan telling me he thought he had "solved the difficulty." Of the lamps I tested the highest resistance would be not more than 24 ohms. Towards the end of 1879 Edison's name was frequently mentioned, as he was inundating this country with communications as to the great things he was doing. Mr. Swan never said to me that he was afraid Edison would be before him.

Mr. GEORGE HOWARD PATTERSON examined by Mr. GRAHAM, said: I am now an earthenware manufacturer at Gateshead, but was articled to Mr. Swan as a chemical and scientific apparatus dealer from January, 1876, to January, 1880, and was with him to June, 1880, as assistant. My father was a manufacturer of pottery, and had ovens for baking pots. Mr. Swan gave me small crucibles and asked me to put them through my father's furnaces and bring them back to him, which I did. They were put through the furnaces with the earthenware in the ordinary process of manufacture, and taken out with the earthenware. I am not perfectly clear whether I ever saw Mr. Swan pack any of the crucibles, but I am perfectly certain that I saw him unpack at least one after it had been baked. I saw him take out small strips of what had apparently been, and what I was given to understand had been, paper; these had been wrapped in paper and packed in powdered charcoal of some kind. I should say I took at least half-a-dozen crucibles to be baked, but am not certain as to the exact number. The strips I saw taken out had a dark blue or greyish appearance; they were of varying widths, from $\frac{1}{4}$th of an inch or less to $\frac{3}{16}$ths or $\frac{1}{2}$ of an inch, and in length about $1\frac{1}{2}$ inch or 2 inches; in thickness they were thicker than newspaper, about the thickness of a visiting card. I took some of these crucibles to be fired prior to October or November, 1877; the one I saw opened was amongst the first, and prior to the date named. I only remember taking one crucible to my father's after 1877. My father's works were at Sheriff Hill, Gateshead, where he also lived until December, 1877, when he removed his dwelling. The furnaces were raised to a temperature which would make anything put into them of a bright red heat; in the particular furnace in which these crucibles were fired the heat was raised very gradually, it taking 24 hours to raise it to dull red heat. I saw nothing done with the strips of paper after they were taken out of the crucible. Mr. Swan himself took off the covering of the crucible, and lifted out the paper strips. I remember Mr. Swan trying some lamps in a room in which I worked, testing the light, and exhibiting them to others. This was prior to the date of Mr. Swan's first public lecture, in January, 1877. I myself fitted up the batteries, and I saw Mr. Swan insert in a stand an egg-shaped lamp and connect it with the batteries, not only on one, but on several occasions. The conductor in the lamps I refer to was straight; in one case it was flat in cross-section, and in another, circular. These lamps were incandesced for varying lengths of time up to several minutes. Wires of platinum were inserted in each end of the bulbs and were connected to the ends of the carbon conductor. How the union was effected between the carbon and the platinum I cannot say of my own knowledge; the platinum wires were fused into the glass. One of the lamps I saw resembled F. J. B. 1 (Swan's stick lamp), and the other had the flat burner I have referred to, otherwise also resembling this. I have seen several persons at Mr. Swan's when the lamps were being exhibited, amongst others Mr. Proctor, Sir William Armstrong, Mr. John Patterson, and Prof. Herschell. I heard no instructions as to secrecy regarding the lamps. I was present at the lecture on February 3rd, 1879, at the Literary and Philosophical Institution, and remember Mr. Swan exhibiting a lamp upon that occasion similar to F. J. B. 1. The burner became heated to a red heat, giving nothing like the light that incandescent lamps give now, and remained alight for some minutes, when the current was switched off. I believe the bed plate of Mr. Swan's gas engine came to Moseley Street on Monday, March 3rd or 4th, 1879; I was away in consequence of the death of my mother until the end of that week, and when I returned, the gas engine had been erected. I saw Mr. Swan experimenting with other lamps between that date and November of the same year. The bulbs were much rounder, and had a long handle or stalk, resembling altogether the radiometer in shape; the conductor was coiled. The leading in wires were of platinum and were fused at the end of the bulb and also at the bottom of the tube. I saw several lamps of that kind alight in the engine room at Moseley Street prior, certainly, to a fire which took place in January, 1880; they were burning there for varying lengths of time, and I do not remember any breaking down.

Cross-examined by Mr. ASTON: I was with Mr. Swan during portion of the year 1880, but did not render him any assistance with his lamps in that year; nor do I remember seeing any lamps burning in 1880, unless I may have seen any before the fire on January 17th or 18th, after which the business was disorganised. I do not remember ever seeing any lamps similar to those the fragments of which are shown to me, nor do I remember seeing any lamps with copper wire inside the bulb. I cannot exactly state when I first saw these lamps in the engine room, but I saw them in other rooms before the then manager, Mr. Mayfield, left, in September or October, 1879.

Mr. JOHN THOMAS MAYFIELD, examined by Mr. Graham, said: I am now an electrician carrying on business in Queen Victoria Street, London, and was formerly manager to Mr. Swan's scientific apparatus department from April, 1874, to October, 1879. I remember Mr. Swan experimenting with incandescent lamps. The first lamp was a glass globe, with platinum leading wires connected at the two ends, and a strip of carbonised material, the glass being exhausted. The carbon was about $1\frac{1}{4}$ inch long, $\frac{3}{16}$ths of an inch in diameter, and about $\frac{1}{100}$th of an inch thick. I first saw that lamp in October or November, 1878. The conductor was made of carbonised paper. Mr. Swan experimented in every direction, and everything carbonised was tried. The conductors were carbonised at Mr. Patterson's potteries. I have had a crucible handed to me to be packed in a further crucible together with charcoal, and afterwards luted down. I saw that lamp giving light several times in Moseley Street. It was at that time a scientific curiosity; it was never burnt for more than a few minutes at a time. Other people than myself saw this lamp; Prof. Herschell, Mr. Barkis, Mr. Patterson, and Sir William Armstrong, I remember, saw it. The first lecture I remember Mr. Swan giving upon a lamp was at the Literary and Philosophical Institute on February 30th, 1879; that was the carbon stick lamp similar to F.J.B. 1. I performed the experiments with the lamp as Mr. Swan's assistant; it burnt for about five minutes and was then put out. It gave a good light for those days—it was above red heat—but a poor light for the present. I recollect other lectures by Mr. Swan at Gateshead and at Sunderland. The lamp shown at those lectures was, I believe, the same as that shown at the Newcastle lecture. My impression is that at Sunderland as soon as Mr. Swan described an incandescent lamp it was turned on and remained on for the rest of the lecture, for half or three-quarters of an hour, when it was put out; the burner was at a yellow heat. Various lamps came to Mr. Swan's premises in 1879. The external appearance of these resembled the radiometer; the burner was thinner than any I had seen before, and was in the shape of a horseshoe or bridge. The leading wires were platinum. I have no recollection as to the junction between the platinum and the carbon. These lamps arrived in twos and threes from Rock Ferry at different times. Those lamps were tried in the engine room. Other people saw them.

Cross-examined by the ATTORNEY-GENERAL: Was the lamp the dimensions of the carbon of which you have given the lamp which Mr. Swan displayed at his lecture?—No, one previous to that.

Was it better or worse than what he showed at the lectures?—It was quite as good.

Do you represent that Mr. Swan did not show his best lamp?—He could not have shown this, because it was broken.

That is not my question. Did he show his best lamp?—He did.

How was the other lamp broken?—As far as I remember mechanically, not by the current. It was by a fall, I believe, in December, 1878.

When this was broken did Mr. Swan make another one?—Mr. Swan made many others.

Did he make another of the same kind?—I am not at all sure.

Was it not because of this being broken down, or whatever it was, that he had prepared for himself F. J. B. 1?—I should say no.

F. J. B. 1 you know, do you not, was blown and exhausted by Stearn?—Yes; all lamps of that time were, so far as I know.

Will you undertake to say that any lamps came from Stearn between July and November, 1879?—It is impossible to confine myself to those dates.

Do you remember four or five parcels coming in that year?—Probably more.

I put it to you that there were 12 to 15 lamps from Stearn in that year?—More than that.

Was anyone else making, blowing or exhausting for Swan in that year?—Not to my knowledge.

Of the lamps that came from Stearn, can you say whether or not a great many of the carbons were broken?—I cannot say one way or the other.

Mr. JOHN RIDLEY, examined by Sir HORACE DAVEY: I am an electrical and mechanical engineer, and live at Newcastle-on-Tyne. On March 5th, 1879, I erected an Otto gas engine for Mr. Swan at Moseley Street, and fixed some Gramme dynamos for running lamps. The dynamo machine was at work on or about April 5th, 1879, running lamps. I continued to work for Mr. Swan and to supply him with articles up to the end of the year, through the following year, and in part of 1881. I was frequently at Mr. Swan's place in Moseley Street, and many times saw the dynamos driving lamps. I saw there Mr. John Cameron Swan, a brother of Mr. Joseph Swan, Prof. Herschell, and Mr. Proctor before December in 1879. I was there three or four times a week from

March 1879, and frequently saw the dynamos running. I saw lamps running from the dynamos, and also saw them cold. The carbon conductors of the lamps were round and of horseshoe shape, with a loop at one end.

Cross-examined by the ATTORNEY-GENERAL: I have no other memoranda of what took place at Mr. Swan's than my day-book, produced. Lamps such as I have described, with horseshoe loop conductors, were run when the dynamo was first put up. I never saw a lamp without a loop until I came to the exhibition at the Crystal Palace. I knew in 1880 that the carbon was made of thread, but not until the latter end of the year. I was not at Mr. Swan's from May 24th until October 3rd, 1879. I saw the dynamo run in 1880 for transformer or induction experiments.

Mr. WM. MENZIES, member of a firm of consulting engineers at Newcastle, examined by Sir HORACE DAVEY, said his firm were the agents for the firm of Crossley and Sons, makers of the Otto gas engine, and he remembered supplying Messrs. Mawson and Swan with a gas engine early in 1879. He saw the engine running and driving a dynamo, which was illuminating a number of lamps. He went with his partner towards the end of the year, partly out of curiosity to see the lamps, and partly to advise as to the best way of remedying the irregularity or "jump" in the lamps caused by the explosions in the gas engine. The lamps he saw in that year had an elongated horseshoe burner with a turn at the top. Those were the first lamps he had seen, and they were nearly as good as those to be seen now. There were 20 or 30 of them up on a partition.

Mr. CHARLES BLACKBURN, partner of the previous witness, gave similar evidence. He saw one of the lamps of 1879 broken, and had a piece of the carbon in his hand; it was of thread and something like horsehair. Saw several people at Mr. Swan's who were unconnected with his works. Was never enjoined to keep secret what he saw. His first visit was within three months of the time when the dynamo was started, in the beginning of April. A second fly-wheel for the gas engine was ordered through his firm, but he could not give the date.

JOHN LENG, brass finisher, Newcastle, who was working for Mr. Ridley in 1879, also remembered seeing the lamps running from the dynamos whilst engaged at Mr. Swan's upon the gas engine and dynamos in 1879. The lamps had conductors like threads with loops.

Cross-examined by Mr. ASTON: The second fly-wheel was put up in 1879; he remembered this because a man who assisted him in putting it up left at Christmas of that year.

The Court here adjourned.

MONDAY, MAY 13TH.

Mr. RIDLEY was recalled and cross-examined by Mr. MOULTON with reference to entries in his book in connection with certain countershafting, which he had said was lent by him to Mr. Swan, he charging only for the men's time in erecting it, &c. He said there was a reference to this countershafting under the date November 8th, 1879, railings and standards having been that day supplied for erection to protect people from the countershafting. The countershafting itself had been fixed for some time previous. Work was done in connection with the countershafting in 1880, probably changing the sizes of the wheels from time to time.

Re-examined by Mr. FINLAY, witness said he could give no definite date as to when the countershafting was put up.

Mr. EDWARD WILLIAM TURNER, second class superintendent in the Liverpool telegraph office, living at Rock Ferry, examined by Mr. FINLAY: Mr. Charles Henry Stearn was in 1879 a neighbour of mine at Rock Ferry. I had communications with him upon the subject of electricity, and particularly with reference to electric lamps. He had a workroom in his house. I have been present in that room when he has been running lamps. I first saw one of his lamps in the summer of 1879. I saw two or three lamps run during that year, in the months of July and August. The room was darkened when I saw the first, so I cannot describe it. The second Mr. Stearn held up to the light for me to see. The burner was a simple loop of thread, formed like a bow. This burner was enclosed in a globe-shaped glass, having a stem and a pointed top; the connections of the burner were down the stem. There were three or four lamps of this kind. Mr. Stearn usually asked me to come and see his experiments, and called my attention to the peculiarities exhibited by the lamps. I do not remember seeing these lamps alight, but could see that they had been lighting, because they were blackened. I saw the threads out of the lamps on Mr. Stearn's table, and handled them. They were of the shape of long horseshoes, and about the thickness of sewing thread. The material was like flax thread. One of the threads was slightly frayed. Nothing had been done to these threads; they were in the natural condition of a thread. I have seen various people at Mr. Stearn's, and was never told to observe secrecy with regard to what I saw.

Cross-examined by Mr. ASTON: You saw other lamps at periods subsequent to the time when you saw the lamp you have described?—Yes.

And those periods extended down to 1880?—They did, to November, 1880.

You cannot tell what lamps you saw at one time and what at another?—I can only speak particularly of the thread with the frayed appearance.

And you cannot tell exactly when that was?—That was in the summer of 1879.

JOHN ALLEN, battery man in the Liverpool telegraph office, examined by Mr. FINLAY, said he was introduced by the previous witness to Mr. Stearn in the summer of 1879, and went to fit up the latter's batteries at his house at Rock Ferry. He there saw electric lamps. One which he saw in August, 1879, was pear-shaped, with a carbon burner of horseshoe shape and thread-like in appearance. He saw half-a-dozen like this. The lamps were tested and packed in a box, and sent, he understood, to Mr. Swan at Newcastle. Many people besides himself saw the lamps, and he was never enjoined to secrecy.

Cross-examined by Mr. ASTON: You continued to assist Mr. Stearn down to what date?—I was occasionally backwards and forwards up to the spring of 1880.

Had some of the lamps straight burners?—All that I saw were of horse-shoe shape.

Does this describe the lamp of which you have spoken: "A kind of globe-shaped glass, with a stem of glass also, and connections leading down to the stem in which were the wires which communicated with the battery?"—Yes.

ROBERT ROBERTS, a carpenter and joiner, of Rock Ferry, gave evidence of doing work for Mr. Stearn, making boxes in which lamps were packed and sent to Mr. Swan at Newcastle. He saw lamps with horseshoe burners in July and August, 1879.

Mr. PERCY SELLON was recalled, and identified an exhibit of carbons put in as carbons which he had purchased of M. Carré in Paris.

Mr. FINLAY said that, subject to calling Major-General Webber to identify another exhibit, that was the evidence for the defendants.

Mr. ASTON said his side desired to call evidence to rebut the evidence given by the defendants.

Mr. JUSTICE KAY: That you have a right to do. You have not called Edison?

Mr. ASTON: No, my lord.

Mr. JUSTICE KAY: Nor Cheesbrough?

Mr. ASTON: No, my lord.

Mr. JUSTICE KAY: Then, do you object to the passage in Edison's subsequent specification beginning "I have discovered," &c.?

Mr. ASTON: We leave that in your lordship's hands.

Mr. JUSTICE KAY: No, no; that you cannot do. It is for you to say whether you object or not.

Mr. ASTON: We can't call Edison, my lord.

Mr. JUSTICE KAY: I do not wish to dictate to you for one moment. You do not call Edison, and you made an objection. All I want to know is, whether you now object to this being received as evidence, or not?

Mr. ASTON: Not as evidence, my lord.

Mr. JUSTICE KAY: Then you do object? I cannot help using that against you, for what it is worth, if you do not object.

Mr. ASTON: Well, there it is, my lord, for what it is worth. We could call Cheesbrough, but he is only a patent agent.

Mr. JUSTICE KAY: I do not wish to dictate to you as to how you are to conduct your case. Conduct it as you like. But I wish to know whether you object to this subsequent statement or not. I understand that you leave it for what it is worth?

Mr. ASTON: Yes, my lord.

Prof. JAMES DEWAR, F.R.S., examined by Mr. MOULTON, said: Since the year 1872 I have given great attention to the behaviour of carbon at high temperatures, both by arc and incandescent heating. I have been in Court most of the time and have heard the evidence given by the witnesses for the defence. In 1879 the process of carbonisation was a perfectly well-known process. It has been known, speaking of definite knowledge, since the middle of the last century, that all vegetable and animal substances leave a deposit of carbon under what we call destructive distillation, or heating at a high temperature. Absolutely nothing has been added to the stock of knowledge as to carbonisation as required for the objects of this specification since November, 1879. Merely the exclusion of atmospheric air was necessary for the carbonisation of filaments. That was effected either by heating in a closed vessel, the volume of which was not very large in comparison with the size of the body to be carbonised, or the substance was placed in a larger vessel and packed in powdered charcoal and other inert substances. This was known at the beginning of the century. I have myself tried carbonising in sand, in a crucible of the same size, about four cubic inches, as that mentioned by Prof. Crookes. I placed in this 100 pieces of vegetable fibre, four or five inches long and $\frac{1}{50}$th of an inch in diameter, filled it with coarse sand, and luted on the cover in the ordinary way. I then placed it in a crucible of larger size, which was otherwise left empty, but covered and luted, and placed in a furnace heated to a full red heat. I allowed it to remain for two hours, keeping up the heat. The filaments were of broom, and were placed in the crucible in their natural state. As far as I could estimate I lost from three to four per cent. of the filaments put in; those were lost in removal. None were attacked by oxygen. The sand employed in packing was common sea sand. I do not think anybody who desired to carbonise a small object in 1879 would have had any difficulty in doing so. I repeated the experiment of carbonising with sand,

using a crucible containing a mixture of carbon with clay instead of a fireclay crucible, but using no outside crucible. This experiment was perfectly successful. I did nothing that was not common knowledge in 1879. I have mounted one of the filaments in a lamp, and have since run it for an hour. There is a slight deposit, but I see no signs of its being likely to break down. The deposit shows that the joint was not sufficiently carbonised, and that some of the tar remained. This was merely an experimental lamp; if I made two or three like that I am sure I could succeed perfectly. The only objection to that is the deposit in the glass; the joint is perfect. Distortion during carbonisation does not prevent useful filaments being made. No precautions are necessary other than packing in fine sand or fine charcoal. I have tried making a lamp with the tar and putty filaments described in Edison's specification. The rolling out of a tar and putty filament is a mere question of manipulative skill. The broom from which I made the filament is a kind of grass which is used for the purpose of making filaments, but any vegetable fibre will do. I simply rolled the filament out between two flat surfaces of glass; flat surfaces of paper or wood would do as well. I do not think any directions would enable anyone to roll such a filament who had not the manual dexterity; where the manual dexterity existed no instruction would be necessary. Edison's description of the consistency of the material to be employed is the only mode in which you could convey the physical state of the body which would work. The language of the specification quite clearly refers to a putty made of tar and the ignited lampblack; the word "moistened" creates no difficulty. I have a lamp made from a tar putty filament, and mounted and exhausted it in the ordinary way. In this case the putty and the tar at the joint were carbonised at the same time. This was carbonised in carbon, with the platinum wires attached. I have run that lamp for about two hours, and think it is a very good experimental lamp indeed. Supposing that mode of making lamps were reduced to practice, and carried out on a large scale, I see no reason why it should not produce perfectly practicable lamps. This lamp was neither "run on the pump" nor subjected to Cheesbrough's process; if it had been it would have been greatly improved. I have made an experiment, cutting from a length of platinum wire two equal pieces, and placing one of the pieces in fine lampblack, heating it to a white heat in a furnace for about two hours. I then took the resulting platinum, which had the appearance of having been slightly attacked on the surface, and in order to test its porosity I sealed it into a glass tube, and then sealed into a similar tube the platinum which had not been carbonised. I exhausted the two tubes simultaneously, so that they had each the same vacuum. They then had an identical appearance after the electric discharge had passed; if there was the slightest leak into one of these tubes the alteration in the appearance is the most delicate test we have of an impaired vacuum. By heating in the presence of carbon the power of occluding gases is diminished in platinum. I have made a further experiment, the result of which shows the deleterious effect of silicates in the presence of carbon upon platinum. This phenomenon is quite well known. Boussingalt speaks of it in a paper in 1876 on "The Siliciaration of Platinum," published in Vol. 82 of *Comptes Rendus*, but the fact was known long before that. I think there is absolutely nothing in the suggestion to insert the platinum wire into the lampblack and tar compound before carbonisation, which would act prejudicially. I have tried rolling a thread in lampblack and tar, finding no difficulty whatever. Working with oxide of zinc and camphor is, in my opinion, practicable. I have carbonised filaments rolled out in lampblack containing these substances. I saw no difference in the results with these. I used 5 and 10 per cent. The volatile powders would be entirely driven off in carbonisation, and according to my interpretation of the specification that is what Edison intended. Powdered camphor is very easily volatile, and one would infer that it would behave in the same way as other volatile powders. Oxide of zinc would be reduced with metallic zinc, which would be volatilised at a red heat. By being reduced the oxygen would *pro tanto* attack the carbon; about 1 per cent. would be reduced. The use of plastic lampblack and tar is an admirable way of making a joint between carbon and platinum. I have tried carbonising both before and after joining, and found both methods equally successful. In the lamp put in by Mr. Crookes as an Edison lamp of the present day the joint is made with putty and lampblack. When the tar putty is rolled fine, the filaments can be made into the form of a spiral. I have a specimen of a filament so coiled. Supposing the winding of the spiral were made so close as in that specimen, it would have the effect with regard to radiation which Edison mentions. Judging from my experiments, all the methods of making filaments mentioned by Edison can be carried out. I have tried the coiling round a helix of copper wire and succeeded, and after carbonising treated it with dilute nitric acid to dissolve away the copper. I did not mount the filament, but was satisfied that it was a practicable thing. Nitric acid has no action on carbon, and unless rapid dissolution takes place, when the heat caused by the rapidity of the gases coming off might break a filament, no injury would be caused. I ran one of the lamps put in for about 20 hours at a white heat. A good light was given out. I did not run the other, because it seemed to me that the tar had not been distilled off properly. The lamp I took is, I think, in a very good condition now. Beyond the fact that the glass was not so clear, I have not the slightest doubt that it would work well if properly exhausted. With regard to the non-conducting, non-carbonisable material mentioned in Edison's specification, I gather that its intended use is to isolate one coil of the close spiral from the others during carbonisation. I have tried experiments with coated filaments to see if a workable lamp could be made. I produce a specimen of an ordinary Edison lamp, made, I believe, from bamboo fibre; I opened that and coated the filament with lime. I exhausted the bulb and ran the lamp for about three hours. A great part of the lime has been knocked off by the action of the current. The lamp shown to me (W.C. 27) has the appearance of having been coated before carbonisation. It is a Swan lamp. I opened that lamp and coated the filament with silicate of soda, mixed with alumina. This has not yet been run; it is merely intended to show the operation of coating. W.C. 28 has been coated in the same way with silicate of soda. W.C. 29 and W.C. 30 are similarly coated to the others. Used in Edison's way as an exceedingly thin coating on the outer surface, it does no damage to the working of the lamp. I should have used the filament if I had possessed the manual dexterity to roll a close spiral. With regard to the specimen of a spiral, broken, put in by Mr. Percy Sellon, I am not a practical lamp maker, yet I think I could do better than that. I say it is not necessary, in order that lamps may have proper life, that they should be freed from impurities.

Mr. JUSTICE KAY: It depends upon what you call "proper" life.

WITNESS, continuing: Parchmentising to a certain extent eradicates the impurities; that process is not intended to deal with impurities, but with the character and structure of the resulting carbon; it makes the carbon more homogeneous. It is a matter of practice to get lamps that offer the same resistance, and so run together. With the exception of Cheesbrough's process I do not know of any operation that will make lamps uniform. If filaments were made in large numbers, it would no doubt be easy to group them in such a way as to have lamps of the same resistance. Before the date of Cheesbrough's specification, I made a great many experiments with carbon, especially in reference to the electric arc. I have known Despretz's paper ever since the year 1872, and I know the kind of carbon which his process will produce. In 1879 I was engaged in a research in which I was very anxious to get carbon tubes which were not porous. I tried to improve all the carbons I found in the market by subjecting them to Sidot's process. I did not, however, succeed. It never struck me to use Despretz's process for the purpose of improving carbon and making it non-porous. The effect of Cheesbrough's process is exactly what he has described; it produces a carbon which is much more homogeneous than any that can be produced by furnace deposition. The hydro-carbon forms a deposit which lodges in the carbon. I produce two pieces of carbon, one subjected to Cheesbrough's process, the other not. One is much more homogeneous than the other. This process has an immense effect in improving the filaments for incandescent lamps. Cheesbrough's own description of the process is an admirable one. There is no doubt that the result is the same whether you use the original pencil or cut pieces from it. The Despretz paper did not lead me to use the process described in Cheesbrough, and I can't imagine that it would lead anyone else to do so. I have made the experiments described by Despretz, and have obtained exactly the same results as he obtained. I submitted the specimens produced to the process; one of them in an atmosphere of nitrogen. After the experiment carbon is doubled in volume, and is completely changed into graphite. In another instance the process was conducted in carburetted hydrogen. The result was a non-homogeneous carbon, which, therefore, is not similar to that produced by Cheesbrough's process. Using such a current as Despretz employed, graphite inevitably results. Here is a specimen in which the carbon has been heated in the electric arc; the result is very irregular, the carbon being changed into graphite at one or two points. That was operated upon in the ordinary atmosphere. I cannot say whether one of the experiments of Despretz, conducted in carburetted hydrogen, was an incandescent or an arc experiment. I made experiments with Sidot in 1879, and again in 1886, for the last action. There is no parallel between the Sidot and the Cheesbrough processes, unless it is the deposition of carbon; they have nothing in common. Sidot's process has no beneficial effect, except so far as general conductivity is concerned. It has no automatic remedial effect in filling up the deficiencies; that can only be caused by the passage of the current.

TUESDAY, MAY 14TH.

Prof. DEWAR this morning produced the plates of glass with which he rolled his tar putty filaments, and repeated the experiment in Court, producing a filament $\frac{1}{50}$th of an inch thick. This filament he then mounted on platinum wires. Continuing his evidence, he said: In the course of a large number of experiments in spectroscopic work I have had occasion to observe the behaviour of lime in the presence of carbon. In conjunction with my colleague, I made experiments at the highest temperatures we could produce in a furnace, and at that temperature could get no evidence of the production of carbon by the action of carbon on lime. I have never been able to find carbide of platinum formed by igniting carbon at a high heat in the presence of lampblack. I have repeatedly heated platinum in the presence of lampblack to the melting temperature, and in those cases there were no formations of carbide of platinum.

Cross-examined by Sir HORACE DAVEY: Prior to 1880 for what purpose was carbonisation used, by what trades or manufactures?—It was used of course for gunpowder, and for every purpose in which carbon was wanted. It was employed of course in every chemical laboratory.

In what trades or manufactures?—I say it was used in gunpowder making, it was used for the products of charcoal, it was used in every chemical laboratory, and especially in connection with blowpipe making.

For the purposes you have described, was it or was it not necessary to provide against the deterioration or consumption of the carbon in making these small carbon filaments?—I say, no; it is still carbonisation, whether it is a big substance or a small one.

Was it necessary to take some precautions against the deterioration of the carbon as it is in the case of these small pieces?—If you compare the manufacture of wood carbon with the production of the filaments, I should say at once that these would require more precautions.

Then do you argue that the loss by depreciation, say in gunpowder manufacture, was not so important as in the case of these small filaments?—In gunpowder manufacture it is the quality of the carbon and the temperature at which it is made that are important.

I am not talking about the quality of the carbon. I ask you whether the deterioration or consumption of the carbon was so important in gunpowder manufacture as in making these small filaments?—I say that in the production of carbon for gunpowder for many years there has been no deterioration or loss, as the carbonisation has invariably taken place in closed vessels.

Was it so important in carbonising for the purpose of gunpowder manufacture and the other manufactures you have mentioned, to exclude the oxygen as it is in making these small filaments?—I think so, if you wanted a good result.

Mr. JUSTICE KAY: Do you know any trade or manufacture in which ordinary workmen are employed in which the same precautions are taken as are now taken?

WITNESS: I do not know of any manufacture previous to that, unless it was in the use of gunpowder for blowpipe purposes.

Mr. JUSTICE KAY: I will tell you frankly what the effect of this evidence on my mind is. Except in chemical laboratories and by people who have knowledge of chemistry, no such precautions were taken in any ordinary trade or manufacture.

WITNESS: I do not think there was any use for it, my lord.

Mr. JUSTICE KAY: That is exactly what Sir Horace Davey wants to get at.

Sir HORACE DAVEY: Reading Mr. Crookes's description of his experiment of carbonising in sand, what do you say as to the cause of the defect?—I think the defect is quite clear. It was not carbonisation; the whole was burnt up, he says.

He put 100 filaments in dry sand, luted the crucible with Stourbridge clay, then raised the temperature gradually to a full yellow heat?—I did the same.

Then so far as the details of the experiment spoken to by Mr. Crookes, you have no objection to offer to them? You think it was a fair test?—So far as the details are recorded, I may say that I made a similar experiment; his filaments were burnt up, mine were not.

It was sea sand you used, I think you said?—Common sand, such as we use for a sand bath in the laboratory.

Did you mix any carbonate of lime with it?—Absolutely none.

With regard to your lampblack and tar experiments, what kind of lampblack did you use?—The ordinary lampblack, such as I could get from people who sell it.

Was it any special form of lampblack?—Not that I am aware of.

Can you tell me the proportions in which you mixed your tar and lampblack?—I cannot tell you. I merely followed Edison's directions, and mixed them until I had a kneadable putty.

Would not the presence of tar in any form of lamp *pro tanto* be a disadvantage?—Undoubtedly. I don't think anyone repeating the manufacture of a lamp would allow tar to appear again.

You have put in a specimen of a coiled filament. Do you mean to suggest to my lord that that coil, that round piece of paper, is a spiral in the sense in which Edison used the word, or would answer the purposes which he aimed at?—I believe so.

Was not Edison's spiral necessarily one in which the coils were close together?—I think his drawing represents the coils relatively close together.

Mr. JUSTICE KAY: You told me yesterday that coating was to prevent the coils touching each other. Therefore, he must have contemplated their being close together?

WITNESS: He contemplated that in one case, my lord. That does not indicate to me that he was always going to use a close spiral. He says coiled in various ways.

Mr. JUSTICE KAY: Is there anything in the specification which leads you to the notion that he was ever going to use an open spiral?

WITNESS: Yes; when he says paper coiled in various ways.

Sir HORACE DAVEY: That has nothing to do with the tar putty spiral?—Not at that point; no.

Was Edison's object in using a spiral to obtain as small a radiating surface as possible?—That is what he is describing.

And would not that object be wholly defeated by such a spiral as you have shown his lordship?—Oh, yes.

Then, what is the good of it?—I made it as a proof that spirals could be made in the way described by Edison.

Do you put J. D. 9 before the Court for the purpose of showing the possibility of making an Edison spiral from a lampblack and tar wire?—I represent it only as a specimen of a spiral.

Cross-examination was continued upon the Cheesbrough specification until the time of adjournment, witness holding that the processes and results in the Despretz and Sidot alleged anticipations were quite different from Cheesbrough's process and result.

WEDNESDAY, MAY 16TH.

Prof. DEWAR, re-examined by Mr. ASTON, said he made many experiments in 1886 with the Cheesbrough process, but never at that time tried coating a non-conducting substance with carbon, and treating it in Cheesbrough's way. Since the suggestion had been made, however, he had tried it, had mounted the burner in a lamp, and had run the lamp for some time. A prior publication of means of preventing the inconveniences indicated by Edison was to be found in a paper in the *Philosophical Magazine* for 1868 on "Details of the relative contraction of woody fibre in carbonisation, and the production of tubes in small filaments," by Dr. Gore. This paper contained the same thing as Edison described. Distortion of filaments in carbonisation did not affect its efficiency necessarily; the appearance only would be objectionable; distortion, short of rupture, or of a short circuit in the spiral form would do no harm. Rubbing fireclay into the tar putty as done by Mr. Crookes would not, in his opinion, be a proper mode of coating a filament. He had carbonised filaments in a closed crucible with and without packing. There was no difficulty in manipulating lampblack and tar filaments by carbonising in a closed chamber without packing; that was, in fact, the best way to carbonise those filaments. [A small brass crucible was produced and handed to the witness.] In that crucible he had, with Mr. Gimingham, carbonised a filament in the precincts of the court, using no packing and no luting of any description. The filament was a thread so far as he remembered.

Sir HORACE DAVEY urged that this did not arise out of cross-examination.

Mr. JUSTICE KAY said it should have been produced in examination in chief. If it were pursued, Sir Horace Davey would be entitled to ask any question upon it.

Sir HORACE DAVEY, cross-examining: What was the heat at which this was produced?—It was a mere experiment. It was a spirit lamp that was used.

Do you suggest that this coil, or whatever you like to call it, has been heated to a sufficient heat for use as a conductor in an incandescent lamp?—Not at the present time.

Mr. JUSTICE KAY: Then it is not completely carbonised?—It is carbonised, but it does not conduct well enough. It wants to be heated for a longer time at a higher temperature.

Sir HORACE DAVEY: Has it been heated to the degree at which the oxygen would combine with or attack the carbon?—That I cannot say. I think it is probably at a low red heat.

Mr. JUSTICE KAY: What is the use of this? Do you mean to try to make the Court believe that this is a fair experiment?

Prof. DEWAR: I said it was only an experiment, my lord,

Mr. JUSTICE KAY: I am greatly disgusted. I have been sitting here trying as hard as I can to understand, and this is clearly an attempt to mislead me. I am very much disgusted.

Prof. DEWAR: I have no desire to mislead, my lord. I have stated that this was a mere experiment. I did not produce it; it was put to me.

Mr. Justice KAY. You may go down.

Dr. JOHN HOPKINSON (examined by Mr. Moulton) said: I have heard the evidence given on behalf of the defendants, and have made experiments on various points arising out of the evidence. I have seen experiments made with regard to the possibility of carbonising tar putty filaments in a closed vessel without packing. The filaments were carbonised and subsequently mounted into lamps and tested. This I have seen also done with linen and cotton thread. The platinum wires passed through a glass mounting; the wires were attached before mounting. But one filament was placed in the tube, and it was carbonised thoroughly well; it was afterwards mounted and the lamp exhausted. In the case of the tar putty the filament was wrapped upon a cylindrical rod of wood before carbonising and after the attachment of the platinum wires. That rod had to be supported in the cylindrical chamber. From the results of those experiments I have no doubt that carbonisation can be successfully conducted in a closed chamber without packing. The temperature was kept at full heat about half an hour. The heat need not be as high as that at which carbon would unite with oxygen. The lamps were all measured. The one containing the lampblack and tar filament gave 16 C.P. with 67 volts and 1·9 ampère; that would be ·8 watts per C.P. The tests were continued for about five minutes, long enough for the purpose in view. The filament was uniform at that incandescence. That lamp struck me as being a very beautiful lamp. At 6¼ C.P. the cotton thread lamp took 67 volts and ·85 ampère, which also works out to a little less than 8 watts per C.P. I have seen carbonisation conducted with sand packing. Pieces of cotton thread, paper, and bamboo were put in, and the crucible was placed in a gas furnace raised to a bright furnace heat, and kept there for about a couple of hours. They were then taken out, and in the box produced are some samples of the filaments which resulted, two of which were mounted in lamps. I have made experiments to see whether a lime cylinder subjected to Cheesbrough's process could be raised to incandescence. Two experiments were tried; in the first we failed, but the second time we succeeded. The cause of the failure was the means of controlling the current. In the second case a little rod of carbon was thrust through a cylinder of lime. The ends of the carbon were supported by larger pieces of carbon, and the whole was placed under a receiver. Coal gas was introduced in place of the air. Heat was applied by means of the current, and carbon was deposited. Here is the result. If the lamp were filled with nitrogen, it would be very similar to Cheesbrough's fig. 1. The conductor was heated to a

bright yellow while the deposit was going on. I see no signs of reduction in that lamp. I see no reason to doubt that that conductor would stand if it were put into an incandescent lamp. With regard to the sufficiency of Edison's specification, it seems to me that the instructions to make the lampblack and tar mixture of the consistency of a thick putty are the best possible to be given, and I don't see that the instructions with regard to rolling can be amended. I have seen filaments rolled very often between glass plates, and with a spatula. The finest I have seen was probably about $\frac{1}{100}$th of an inch in thickness; that would make a practicable high resistance lamp. The instructions given by Edison are sufficient to enable anyone desiring to succeed to make a practical lamp, and he believed all the methods were capable of producing a successful result. The Cheesbrough process would undoubtedly improve the carbon of a lamp, and there are quite sufficient instructions to enable the process to be carried out. Witness produced a brass tube in which, with the aid of a blow-pipe, filaments had been carbonised. That was a method of carbonising with which workmen were familiar in 1879, and which they would be likely to use.

Cross-examined by Sir HORACE DAVEY: Do you seriously suggest to the Court that any workman in the year 1879, or at any other time, if he wanted to carbonise a material, would use one of these brass tubes as a blow-pipe?—I think it is very likely he would.

As a commercial mode of carbonising?—Whether he could do it commercially or not I do not know.

I am speaking of a man who is engaged in the manufacture of carbons for commercial use. I ask you whether a man in that case would use a brass tube and a blow-pipe?—I think if you were making one filament it would be the most natural thing to do. If you were making a large number it would soon come to introducing some other materials.

I was speaking of a person employed in the manufacture of lamps.—For large numbers I don't think he would; I think he would adopt more modern views of doing it.

Do you represent to my lord that that experiment with the brass tube and blow-pipe is anything more than a laboratory experiment?—Well, of course, it was not made on a commercial scale at all. It was tried with a single filament, and that was the most natural way of doing it.

Do you suggest that it is anything more than a laboratory experiment by extremely able gentlemen?—No, I think it is quite the obvious way of doing it.

Do you put it before the Court as anything more than a scientific curiosity?—Yes, I think those lamps would at that time have been perfectly practicable lamps. I do not mean that they would compete with lamps now.

Do you suggest that in November, 1879, there was any practical mode of carbonising in any trade or manufacture where carbonising was required?—I don't know whether there was any similar trade to this.

Then you are not prepared to say that there was any body or class of workmen in November, 1879, who would have carbonised in the mode you have described, with the brass tube and blow-pipe?—It appears to me that is following closely and precisely Mr. Edison's directions.

Do you put that forward, then, as what Edison tells you to do?—Precisely.

Where do you find anything about the blow-pipe?—I find nothing about the blow-pipe. I only find "heated to a high temperature."

It has been suggested by counsel for the plaintiffs that carbonisation was a well-known and familiar operation at that time?—So it was.

But that was carbonisation in a furnace, was it not?—In a furnace, in a closed chamber, to prevent the admission of air.

Do you put your brass tube into a furnace?—No.

You would not like to?—Well, you must moderate the heat considerably, or you will melt the tube, no doubt.

What was the character of the flame which you used with your blow-pipe?—It was a large blue flame.

Was it an oxidising or reducing flame?—I should think that the tops of the flame would probably be oxidising; as to the interior, possibly.

Then, the flame which surrounded the tube was a reducing flame?—Possibly; I could not say with certainty.

If the brass tube or vessel was surrounded by an oxidising or reducing flame it would make a great difference on the chemical action inside the tube, would it not?—I don't think so. The tube was practically closed.

It is a very poor sort of carbon, is it not, which is produced at that temperature?—No; you have seen the lamps, and can judge of them.

I have seen the lamps; but I am asking you—and I am sure you will give me a fair answer—whether the carbon at that temperature would be very poor?—No, I don't think so. It seemed to me to be thoroughly good carbon.

You never tried the lamps made from these filaments for duration, I suppose?—No.

You put the glass and all into this brass vessel?—Yes.

What is the melting point of glass?—It varies very considerably. It depends upon the composition of the glass.

But it is considerably below red heat, is it not?—No. Glass becomes softer and softer until it is quite fluid; but to thoroughly melt glass you require a bright white heat.

But it begins to be soft considerably below red heat?—It begins to soften at or below red heat, I should say; but that depends upon the quality of the glass.

The temperature which you used on that occasion, when the glass was put in, was very considerably below furnace temperature?—No doubt it was.

And very considerably below the temperature which is ordinarily used for the purpose of carbonisation?—I believe you do as a rule carbonise at a higher temperature than that.

Now, in your experiments in sand you were good enough to produce a specimen of the sand you used, and I observe that it was very fine white sand?—Yes, it is a white sand which is used for glass making—for making the best qualities of glass.

Is not that sand almost pure silica?—Yes.

And it does not contain any water or moisture?—The question of moisture really depends upon the way in which the sand is used.

As compared with other sands, that fine silica would contain a much smaller amount of moisture, of water?—No, I don't think so.

Most sand contains an appreciable amount of clay?—Common sand no coubt contains a certain amount of clay.

And this sand, which is almost pure silica, would not contain any appreciable amount of clay?—No, it was pure silica.

Mr. JUSTICE KAY: And would not contain any absorbent?—No; it was practically pure silica, containing no mixture whatever.

Sir HORACE DAVEY: And clay would be the element which would be most absorbent?—No doubt.

You say you have seen a bulb blown over the burners and platinum wires?—Yes.

That was not the ordinary way of making a lamp?—No, I don't think anyone would do that ordinarily.

You said a clever glass-blower could do it?—Yes.

No one would dream of practically using that method of making a glass lamp?—Oh no, I think they would form the bulb first. The experiment was only tried to show that it could be done.

You would not let me call that a scientific curiosity?—I don't think it could be called a scientific curiosity. A curiosity if you like. That would not be a general way of doing it.

The lamp J. H. 10 contains a bamboo filament. Is the joint there made in accordance with Edison's specification?—It is intended to be so.

Do you attach the leading wires to the filament before carbonising?—I have done it both ways. In that case the carbon was attached to the wires after the carbon was carbonised.

Then you carbonise again?—Yes.

That yellow substance, I believe, is tar. I suppose you would agree with the other witnesses that the presence of tar in a vacuum would be a disadvantage?—Oh, yes; no doubt there would be a certain quantity of hydrogen left, and any residual gas left would impair the lamp to a certain extent.

The presence of tar, therefore, would be a distinct disadvantage?—If it is left in. It ought all to be driven off; none ought to be left behind at all.

Can you tell my lord where there is one single line in Edison's specification which tells you to get rid of all the tar?—I do not think he calls your attention specially to that.

Re-examined by Mr. ASTON: You were asked whether Mr. Edison's specification contained directions to drive off the tar. Look at page 4, line 44: "The ends of the carbon or filament are secured to the platina leading wires by plastic carbonisable material, and the whole placed in the carbonising chamber." What would be the effect of placing in a carbonising chamber?—No doubt the effect would be to drive off the tar.

With regard to blowing the glass bulb over the leading wire before exhaustion, assuming that anybody were to take that to be the direction, would an incandescent lamp be capable of being made by blowing the globe over in that way?—Yes, no doubt. At the same time I should say that on reading this it never occurred to me that that was intended.

You say there was no similar trade to that of making filaments for incandescent lamps. What do you say of the old school of manufacturers of carbons for arc lamps?—That is considerably analagous.

Do you think workmen accustomed to this trade would understand the meaning of carbonisation?—I should think so.

And the meaning of carbonising in a closed chamber?—Yes.

Dr. FLEMING (examined by Mr. ASTON) said he remembered Mr. Johnston, Mr. Edison's assistant, coming to England in the beginning of 1880 with a box containing half-a-dozen carbon incandescent lamps. These lamps were put up in a room in Queen Victoria Street, and operated by means of galvanic batteries. They were arranged in parallel. The carbon conductors in these lamps were clamped on to the platinum wires. The carbon conductor, to the best of his recollection, was a very thin piece of paper of horse-shoe shape. The lamps gave very excellent light. They were exhibited on and off for several weeks, sometimes for some hours at one time. He knew of the use of the closed chamber for carbonising carbons for the electric arc, but could not say positively that he had heard of carbonising in charcoal before 1879; he thought he first heard of that in 1881 or 1882.

Cross-examined by Mr. FINLAY: The lamps brought over by Johnston he saw in February, 1880. He could not say whether or not they were made under Edison's specification of December 15th, 1879. They were generally similar to the lamp shown in the figure accompanying that specification, but he could not recollect the exact details.

The ATTORNEY-GENERAL said before the Court rose he would like to mention one matter. He understood that his lordship had

made some observations with regard to a point earlier in the day when he was not present, and he would ask that the exhibit to which it related, the brass crucible, might be returned to the plaintiffs, for there seemed to have been some mistake. Prof. Dewar appeared to have been misunderstood, and they wished to repeat the experiment.

Mr. JUSTICE KAY: You must ask your opponents. I must say that Prof. Dewar made a very unpleasant impression upon my mind.

The ATTORNEY-GENERAL: I am sure your lordship will believe that neither my learned friends, nor myself, would appear in this case if we thought there was any attempt to mislead. We think there has been a mistake and would like the experiment to be done again, if Sir Horace Davey raises no objection.

Sir HORACE DAVEY: This places me in a peculiar position, my lord. Of course the evidence has been given.

Mr. JUSTICE KAY: I shall not give my permission for the exhibit to be returned without your consent.

Sir HORACE DAVEY: Then I shall not consent.

The Court then adjourned.

(To be continued.)

[Yesterday (Thursday) Mr. Swan was the only witness called. He detailed the history of his experiments in the construction of electric incandescent lamps. He stated that he carbonised strips and coils of paper in charcoal in a potter's kiln in 1848. These he packed in charcoal powder. His first thread lamp, he said, was certainly not made before the middle of the year 1880. Much of his evidence was in direct contradiction of that given by the witnesses who spoke to having seen lamps at his premises in 1879. We shall give the evidence fully next week. When the Court rose, the further hearing of the case was adjourned until Wednesday, May 30th.]

NOTES.

Anonymous Correspondence.—Last week we were discussing with an eminent electrician the question of allowing correspondents to air their views or cast reflections upon the *bona fides* of others in our columns under a *nom de plume*. The subject had been previously broached on more than one occasion, and our friend pointed to our esteemed contemporary *Nature* as an example of a journal which never allowed a letter in its columns unless signed by the writer, but whose last issue, nevertheless, contained a lengthy epistle over the initials A. B. This, of course, shows that the laws of nature are not, as has hitherto been supposed, inflexible. Now we have the complaint of the Electrical Power Storage Company, which, although more imaginary than real, cannot be overlooked, and, after the appearance of our present issue, we have decided to allow, in future, only those letters to appear to which the writer attaches his own name, exception being made to those of purely scientific interest. In looking over some twenty back numbers of the REVIEW, we find fewer than two letters per issue published under a *nom de plume*. It appears, then, that the great majority of our correspondents do not object to state their views and accept the responsibility; and, in the face of this, we think we can safely adopt the policy upon which we have decided without giving offence to any one.

Electric Light in Philadelphia.—The following table shows the progress of the electric lighting of the streets in Philadelphia:—

									Increase per year.
On the 1st Jan.,	1883	there were in use			114	arc	lights		...
"	"	1884	"	"	"	381	"	"	267
"	"	1885	"	"	"	401	"	"	20
"	"	1886	"	"	"	446	"	"	45
"	"	1887	"	"	"	501	"	"	55
"	"	1888	"	"	"	599	"	"	98

Electric Light at the Italian Exhibition.—This exhibition will be lighted on the Thomson-Houston system with 300 arc lights of 2,000 C.P., and 100 incandescent lamps. There are 10 arc dynamos, each of 35 lights, and one dynamo to supply the glow lamps. Davey-Paxman boilers and engines will be used, there being three locomotive boilers each of 100 H.P., one compound undertype combined engine and boiler of 40 H.P., one compound engine of the girder type of 40 H.P., and two Windsor engines of the inverted compound type, each of 30 H.P.

A New Departure in Electric Lighting.—Mr. Henry Albert, of Perth, Western Australia, sends us a letter in which he claims priority over Mr. George Offor for a "New Departure.' Our correspondent has seen a copy of the *European Mail* of the 8th March, in which Mr. Offor is said to suggest that the electric light can be obtained from storage batteries charged from a central station without any apparatus on the consumers' premises beyond a small meter to register the consumption. This, says Mr. Albert, I suggested to Mr. Thornton, the resident engineer to the Midland Electric Light and Power Company, Leamington, in January, 1887, and I think that the "new departure" is due to me. It is not a little curious to see gentlemen continually proposing ideas as something novel which have been apparent to everybody for years past.

Electrically Lighting Railway Stations.—At the second International Railway Congress, lately assembled at Milan, the question of the electric lighting of railway stations was very fully discussed. Some account was given of the various installations of this nature at present existing on the Continent. It appears that but little has been done in France in this direction, the principal installations being at the goods station of La Villette and the station of St. Lazare in Paris, and some partial lighting at Marseilles, Bellegarde, and Lyons. In Germany 46 railway stations employ the electric light, the most important installations being:—Strasbourg, with 70 arc lights and 100 incandescence lamps; Karlsruhe, with 24 arc lights and 250 incandescence lamps; Darmstadt, with 17 arc lights and 170 incandescence lamps; Munich, with 47 arc lights. In Austro-Hungary, Vienna has two stations fitted up with the electric light, one at Buda-Pesth, and one at Feldkirch. In Belgium 17 stations are lighted by electricity, with a total of 163 arc lights and 322 incandescence lamps. Several stations in Italy, notably those at Milan, Turin, Genoa, Pisa, Rome, and Sampierdarena, have the electric light.

Electric Light at Hamburg.—The work of fitting up the free port and docks at Hamburg is being actively prosecuted. The installation will comprise 50 arc lights and about 4,000 incandescence lamps of 16 candles. The arc lights are to be grouped in series of 10, each series supplied from a special machine. The incandescence lamps will be supplied from 6 Schuckert dynamos, running at 350 revolutions per minute, and giving a maximum of 400 ampères at 120 volts. The motive power is to be obtained from three pairs of compound engines of 220 H.P. each. The cables will be laid under ground in rectangular iron conduits.

Electric Light at Rouen.—The Municipal Council of Rouen has received tenders from eight contractors for the installation of the electric light in the theatre of that town; but as the lowest tender was nearly £1,000 in excess of the price at present paid for gas lighting, no decision has been arrived at on the matter.

Electric Light at Amsterdam.—The chief feature of interest with regard to the central lighting station in this town is the low difference of potential employed, a system of distribution at 100 volts being adopted. The current is supplied from two dynamos running at 100 revolutions per minute; these dynamos are each worked directly by a steam motor of 240 H.P.

Electric Light in Germany.—At Dresden there are 30 separate installations, with 157 arc lights and 2,379 incandescence lamps.

Crefeld has 44 installations, with 175 arc lights and 3,209 incandescence lamps.

Bremen possesses 28 installations, with 226 arc lights and 2,251 incandescence lamps.

In Berlin there are 1,650 arc lights and about 26,000 incandescence lamps.

Munich possesses no central station, but there are 43 buildings employing 167 arc lights and 7,936 incandescence lamps, in addition to 2,300 Edison lamps in the Theatre Royal and 800 in the Ministry of War.

Ship Lighting.—H.M.S. *Magiciene* was launched on Saturday from the yard of the Fairfield Shipbuilding and Engineering Company, Limited, Glasgow. She is the first of five twin screw protected cruisers at present building. The vessel will be lighted throughout by electricity, and will have three powerful search lights on the conning tower forward and two aft on the upper deck on the sponsons.

Factory Lighting.—The factory of Messrs. Vicary Brothers, tanners, at Lower Bradley, Newton Abbott, is about to be lighted with electricity, the work having been entrusted to Mr. W. Radcliff, who has successfully introduced the electric light on the stage of Torquay Theatre.

Electric Lighting at Thetford.—The electric light has been in use at the residence of Mr. C. Burrell, at Thetford, for some weeks. Mr. Burrell is now also putting apparatus for electric lighting into St. Nicholas' Iron Works. Several tradesmen of the town wish for it in their establishments if permission can be obtained for the wires to be conducted over their neighbour's houses. Gas at Thetford is 5s. per 1,000 feet, and it is hoped that the new illuminant may prove a cheaper and better substitute.

Central Station Electric Lighting.—The object of Mr. Crompton's paper, which was read on Wednesday night before the Society of Arts, appeared to be the popularising of the electric light. He also endeavoured to show that the time had now arrived when capitalists may safely invest their money in central station enterprises. We shall hope to refer to this paper, and to the discussion, at length next week. Everybody seemed desirous of explaining, mainly we imagine from hearsay evidence, what was going on in America; but the information volunteered was generally of a questionable character.

The Telegraph in Spain.—The thirty-third anniversary of the establishment of the first telegraph line in Spain was celebrated by banquets at nearly all the principal towns, excepting Madrid. At Barcelona the Director of Telegraphs in that town presided at a dinner, during which M. Saavedra gave a very interesting historical sketch of the progress of the telegraph in Spain.

Cable Survey.—The *Melbourne Argus* of 3rd April ult., says :—"Admiral Fairfax has received orders from the Admiralty directing the employment of H.M.S. *Egeria*, now on her way from Hobart, Tasmania, to Sydney, in surveying a route for mail steamers, and for the laying of a cable between British Columbia and Australia. The work, which will occupy three years, will cover an expanse of water 200 miles wide for the entire distance across the Pacific. It is impossible to name the exact point on the Australian coast from which the survey will start, but the route will be by way of the northernest point of New Zealand, passing Fiji to British Columbia, and connecting with the Canadian Pacific Railway."

Electric Lighting at Barnet.—The Barnet Local Board, states the *St. James's Gazette* of yesterday, has affixed its seal to a contract for the lighting of the town by electricity, the contractor being Mr. Henry Francis Joel. The contractor undertakes to light the streets by electricity by the 29th of August, to use underground wires, and to make a charge based on 4s. per thousand cubic feet for gas. He also offers to supply private consumers at a similar rate, or if they prefer it, at a charge of £2 per light per annum. The board has had the choice of arc or incandescent lights, and has decided upon the latter. The contract is for three years.

Glasgow Philosophical Society.—The last meeting for the session of the Philosophical Society of Glasgow was held on May 2nd, and Prof. Blyth described a practical experiment which he made last summer in the application of wind power to the production and storage of electricity. He erected a small windmill for supplying electric light by means of storage cells to a small cottage in the village of Marykirk, where he spent his summer holiday. The windmill was of the old English type, and was erected in the garden. The tower consisted of a wooden tripod firmly fixed in the ground and strongly braced together by bars of wood. The windshaft stood about 33 feet above the ground and carried four sail arms at right angles to each other, each being about 13 feet long. The dynamo, an old form of Bürgin, was driven directly from the flywheel by means of a rope, and a workable speed was attained even when the windmill moved at a comparatively slow speed. The current from the dynamo was employed to charge 12 electric power storage cells, which supplied the incandescent lamps in the cottage. As yet he had only used at one time 10 8-candle-power 25 volt lamps, but he found that storage for more could be quite easily obtained. One day when a good breeze was blowing he stored as much in half-a-day as gave light for four evenings of about three or four hours each. As yet, however, he had not had time or opportunity to test fully the capabilities of his arrangement. For one thing he required a more suitable dynamo and a much greater storage capacity, so as to take advantage of all the wind blowing, and when this was done he had no doubt whatever regarding the complete success of his experiment. While charging the current passed through a cut-out arrangement which immediately disconnected the cell from the charging circuit when the dynamo ran below a certain speed. In this way the windmill could be allowed to run day and night, as it would only store when a certain speed was attained, and the cells were effectually prevented from discharging themselves through the dynamo even should it stop. On several occasions he had used the stored electricity to drive a small turning lathe, and he had begun to make a light form of carriage to be driven by the same. He preferred wind power to water, because the latter was usually tied up. The landlords had not yet claimed a right over the wind, although a place that had a good draught might come to have a money value. Mr. Thomas Gray commented upon the comparatively great cost of the batteries, and suggested that in some cases it might be possible, at a moderate expense, to store water which could be pumped up to drive a turbine. [This should have appeared in connection with a leaderette in our last issue.]

Central Station Lighting in Germany.—In the electric light station at Lübeck, which is designed for 2,000 lamps, but which will eventually be increased, a novel system of laying underground cables, *Industries* states, has been adopted. The method hitherto followed in Berlin and other towns consisted in the employment of either Edison tubes or Siemens lead covered cables, with a sheathing outside formed of spirally wound iron tape. To reduce the cost of the cables the iron sheathing has been omitted in the Lübeck cables, and the lead envelope is protected by a serving of jute heavily tarred. Since these cables are mechanically not so strong as those with an iron sheathing, they have been laid in flat channels of rolled iron with an iron lid. These channels are perforated at the bottom, so as to allow water which may find its way into them to pass out into the ground. Owing to the protection afforded by the iron channels, it has been found possible to lay the cables close under the paving stones. The junction, feeding, and distributing boxes are also smaller and less expensive than those used in Berlin. They are provided with short sockets, into which the iron channels fit. At the bottom of the boxes a plate of ebonite is fixed, to which are secured the various terminals and connections for the fusible plugs. Another departure has been made in the testing wires. These do not form part of the main cable as in Berlin, but are separate light cables brought back from the feeding centres to the station.

A New (?) Arc Lamp.—A correspondent asks our advice as to a suggestion he makes for an arc lamp on the Jablochkoff candle principle, but with continuous currents. He proposes to make the section of one carbon larger than the other, varying sizes and shapes until he arrives at a satisfactory result. All we have to say is that our correspondent is years behind the times, and that he might do worse than read up the history of electric lighting. His proposal is older than the Jablochkoff candle, in which indeed the same thing was tried, and was employed by Werdermann in endless variety.

Legal.—An action has been brought by Charles Edward Hall, engineer, Washford road, against the Telegraph Manufacturing Company, Limited, of Helsby, Warrington, for the recovery of £38 5s. 6d., the price of a carbon crushing machine, with certain extras. On the 10th June the plaintiff agreed to supply the defendants with a carbon crushing machine for £35. This was supplied, but the defendants now contended that in accordance with specifications, the machine would not do the work required. A considerable amount of correspondence was read, in which the defendants complained that the machine did not break the carbon small enough; while on the other hand it was alleged that the defendants did not use the machine properly, and, in particular, ran it at too great a speed, causing risk of accident, and allowing large pieces to go through. Defendants, being convinced that the machine would not do the work required of it, refused to keep it; while the plaintiff asserted that it would do all that they undertook it would do. Judgment was reserved.

Electric Traction Abroad.—The Aerial Railway Company of New York and Haarlem has demanded the authorisation of the Municipal Council of New York to adopt electric traction. We learn that several tramway companies in New York propose to employ electricity as the motive power.

The Electrical Transmission of Power.—The electrical transmission of energy makes rapid progress in America. One company alone, in New York, distributes 200 H.P. among 60 subscribers, and we learn that a new installation for 2,000 H.P. will be shortly established.

The Big Bend Tunnel and Mining Company has diverted the Feather River (U.S.) by means of a tunnel 2⅓ miles long across the horse-shoe bend, in order to carry out mining operations in the old bed of the stream. At the outfall, where the turbines will have 300 feet head of water to work with, there are placed generating dynamos, which will transmit power to 14 stations in and about the old river bed.

Electric Fittings on View.—Messrs. Taylor & Tucker, Limited, notify that they have now opened their new show rooms at 9, Duke Street Mansions, Grosvenor Square.

SS. "Grappler." — The telegraph ss. *Grappler*, owned by the West India and Panama Telegraph Company, arrived in the river last week. We understand that after undergoing the necessary docking, she will take on board some 250 knots of cable manufactured for the company at the works of Messrs Henley & Co.

Lisbon-Cadiz Cable.—We read in the Cadiz journals that the engineers and electricians of the ss. *Amber* and ss. *Electra* were entertained at a banquet given in their honour by the staff of the Spanish National Submarine Telegraph Company in Cadiz. Mr. Wilson the Superintendent of this company, in a felicitous speech, proposed the health of the guests and success to the new enterprise they were about to undertake.

Dividends from Electric Lighting.—The report of the Hastings and St. Leonard's Electric Light Company, Limited, will be perused with interest.

Brussels Exhibition.—It appears that matters are in a very backward condition at the Brussels Exhibition. Most of the buildings are incomplete, and the foreign sections will take some time to put in readiness. The English section must, however, be excepted, where the buildings are completed and the exhibits well forward. The Anglo-American Brush Electric Light Corporation, Limited, has entered into an important contract with the Executive Committee of the Exhibition for the lighting of part of the buildings and gardens by means of arc lamps, and will have the sole right to supply the light to stall exhibitors and others within the area covered by the contract.

Copper Market.—It is reported that the Société des Métaux has contracted with the Cape Copper Company for the whole of its output, for a minimum term of three years, at the rate of £70 per ton. Stocks are increasing steadily, the demand showing a slightly further falling off. The Calumet and Hecla mine has not been opened yet.

Cincinnatti Exhibition.—The centenary exhibition which is to be opened on July 4th next at Cincinnatti will be illuminated with 350 arc lights and 2,000 incandescent lamps.

New Catalogues—The catalogues of electric light machinery are not usually of the most complete or exhaustive nature for many reasons, most of which are well understood. Occasionally, however, one comes across a pamphlet descriptive of a particular class of machine in which it would be difficult to point to a single omission, and of this nature are the second editions of the catalogues just issued by Messrs. Mather and Platt of the "Edison-Hopkinson" and "Manchester" dynamos. For completeness in every detail these will serve as models for others, although we trust that if this opinion coincides with that of rival manufacturers these latter will not copy the phraseology in a wholesale fashion.

Messrs. Robertshaw and Sunderland have sent us a copy of their new catalogue, from which it appears that they deal specially with electric bells and their appurtenances, railway telegraph instruments, dynamos, electric lamps and conductors generally. To large consumers this firm expresses its willingness to send sample goods, and to assist those customers who are only commencing business both with advice and practical assistance when and where necessary.

The City and Guilds of London Institute.—The annual students' *conversazione* of this institution will be held at the Technical College, Finsbury, on the evening of Friday, the 25th inst. The proceedings will include a concert, an exhibition of drawings, apparatus, &c., and also a lecture by Prof. Sylvanus Thompson on Polarisation of Light, and another by Prof. J. Perry on Magnifying Springs.

Copper Wire.—The price for high conductivity copper wire has been reduced one halfpenny per pound, making the present basis price, 0 to 20, 11d. per pound.

An Explanation.—Mr. Killingworth Hedges writes: "By reason of the omission of a paragraph the description, in the REVIEW of May 11th, of the diagram of the supply of electric light to a district is rather unintelligible. The German electrical horse-power is, of course, not 640 watts, but this amount was taken as the outside figure for the calculations instead of 736 watts, the theoretical German E.H.P."

Personal.—Mr. Harry Edmunds will start for the United States to-morrow on business connected with his electrical distribution scheme. Mr. Edmunds has introduced into this country at various times several American electrical inventions of great value. Now he appears likely to make an exchange of still greater utility.

We are authorised to state that Mr. Harwood, to whom we referred in our last week's issue, has not left the Eastern Telegraph Company's service.

The Society of Telegraph-Engineers and Electricians.—At the extraordinary general meeting, on Thursday, 24th May, a paper by Sir William Thomson, L.L.D., F.R.S., Past-President, on his new standard and inspectional electric measuring instruments is to be read.

The Electric Light at Leamington.—There was an animated discussion at Monday night's meeting of the Leamington Corporation on a notice of the motion by Mr. Crowther Davies to give 12 months' notice to determine the contract with the Midland Electric Light and Power Company for the supply of the electric current to the lamps in the Parade. Our readers are well aware of all the untoward circumstances connected with the Leamington installation, so we need not enter anew into the particulars of the case. In support of the motion for determining the existing contract, it was urged that the Midland Electric Light Company had not provided the town with an illuminant of double the power and value of gas, and that the Corporation was not justified in spending £400 on the lighting of the Parade with the electric current when the street could be lighted by gas for £200. Mr. Crowther Davies urged that during the 12 months covered by the proposed notice the company would be able to effect improvements, and if such improvements were satisfactory no one would have greater pleasure than he in withdrawing the notice. He disclaimed any intention of dealing harshly with Messrs. Arthur Chamberlain and Hookham, who were believed to have spent nearly £30,000 on the Leamington installation; but he felt it to be his duty, in the interest of the ratepayers, to object to a payment of £400 a year on such an inefficient system as that with which those gentlemen were at present lighting the Parade. The system was fundamentally wrong, and he feared that it could not be perfected. His Worship, the Mayor, pointed out that the adoption of the resolution would be disastrous to the company, who would lose the enormous sum they had invested in the borough without having had a fair chance of showing what they could do in the way of electric lighting. He complained that the Council were treating Messrs. Chamberlain and Hookham in an unmanly and ungenerous manner. He admitted that the light was not at present satisfactory, but explained that the company had erected a third engine and constructed storage batteries, and was resolved to do everything in its power to make the installation a credit to itself and satisfactory to the town. Mr. Crowther Davies having replied, a division was taken, the result being a tie. The Mayor is said to have declined to give his casting vote, although we notice in another report of the proceedings that he voted for the continuance of the light. The matter we believe remains in abeyance.

Electrical Tramway for Leamington.—An experiment is about to be made at Leamington in electrical tramcars. The Milverton Local Board has given its sanction to the project, and its introduction is looked forward to with exceptional interest. It is believed that the intention of the promoters is to utilise the electricity generated during the day in connection with the Midland Electric Lighting Company.

The Royal Society.—At last night's meeting the following papers were to have been read:—"On the Electromotive Properties of the Leaf of Dionæa in the Excited and Unexcited States."—No. II. By Prof. J. Burdon Sanderson, F.R.S. "Magnetic Qualities of Nickel." By Prof. Ewing, F.R.S., and G. C. Cowan. "On the Structure of the Electric Organ of *Raia circularis*." By Prof. J. C. Ewart.

A Magnetic Crane.—At the Otis Iron and Steel Works, Cleveland, Ohio, an electro-magnet is employed to lift the steel ingots and other heavy masses of iron. When excited by a current of 6 ampères it lifts a weight of 800 lbs. with ease.

Paris Exhibition.—We are pleased to announce that the Executive Council of the Lord Mayor's Committee for carrying out the English section of the Paris Universal Exhibition of 1889, has appointed Mr. John Aylmer, of Paris, as its honorary secretary in Paris. The services rendered by Mr. Aylmer as Secretary to the British Commission at the Paris Electrical Exhibition of 1881 are within the recollection of many, and his experience in the management of exhibitions in France combined with his great tact and personal popularity will be of material help to the English Commission in carrying on the work of the section next year, and contribute in no small degree to the success of its efforts.

Electric Lighting Tenders Wanted.—The Ilfracombe Local Board invites tenders for the lighting by electricity of the Victoria Promenade, now in course of erection. Particulars on application to the Surveyor. It is probable that arrangements can be made for several hotels and other establishments in the neighbourhood, taking the light jointly with the above. Tenders are also required for lighting the borough of Poole either by gas, electricity, or other means for one or three years, at the option of the council, from September 1st next, for the council, the amount of illuminating power in candles to be specified in the tender. Sealed tenders marked "Tenders for lighting," to be sent in conformity with specification to the Town Clerk by 30th inst.

Telephonic Extension in Aberdeen.—It is a remarkable fact, says the *Scottish Leader* of the 15th inst., that, in comparison with its population, Aberdeen is better supplied with telephonic connection than any other town in Scotland. The calculation has been made that in Aberdeen and its suburbs, telephone wires are hung in the ratio of one to every 184 inhabitants. Just now the central office in Market Street is being rearranged, and there are indications that telephonic extension in Aberdeen has not by any means reached a stopping point.

Plymouth Pier Lighting.—A Plymouth paper states that, somewhat to the annoyance of *habitués* of the Plymouth Promenade Pier, the electric light has occasionally demonstrated the fact that it is not altogether reliable. During the concert on Sunday evening it went out, but after some time it went up for a short period, when it again became troublesome. In the interval of the concert on the evening of the 14th the whole of the lights went out, and darkness prevailed for such a lengthened period that the programme could not be continued. Subsequently the lessee, Mr. McBryde, standing on the bandstand, announced to those present that he was making arrangements for supplying gas during emergencies like the present, so that the proceedings at future evenings need not be suspended when the light temporarily failed.

Dental Motors.—Mr. Adam Koerber informs us that he has patented and constructed a motor for dental purposes, and that he is able to assert on the best authority that there is nothing in the market superior to his hot-air engine. The apparatus was devised because of the uncertainty of action in both electric and water motors. Nevertheless, we are of the opinion that an electrically driven dental engine could easily be devised to suit every requirement of the profession, and warranted to give general satisfaction.

Obituary.—We regret that information has just reached us to the effect that Mr. George Adamson Mason, late Manager to the Consolidated Telephone Construction and Maintenance Company, died on Saturday, the 6th inst.

NEW COMPANIES REGISTERED.

Waterworks, Gas, and General Lighting Corporation, Limited.—Capital: 1,000,000 in £10 shares. Objects: To promote and assist in promoting waterworks, gasworks, hydraulic works, electric, and other lighting works, in the United Kingdom, India, or elsewhere. Signatories (with 1 share each): J. J. Gibson, Tooting; H. J. Hogarth, 24, Hanover Gardens, Kennington; H. J. Newell, Wembley, N.W.; W. Whittington, 55, Fleming Street, S.E.; R. Thorp, 44, Farringdon Street; A. A. Bell, 17, Springdale Road, N.; A. Martin, 28, Bellifield Road, Brixton; Malcolm Ross, Bedford Park; E. Thomson, 73, Linwell Road, Camberwell. The signatories are the first directors. Qualification for subsequent directors: £2,000 in shares or stocks. Remuneration: £100 per annum to each directors. Registered 7th inst. by R. Byron Johnson, 50, Parliament Street.

Webster and Company, Limited.—Capital: £100,000 in £10 shares. Objects: To acquire and develop the business of contractors for public works founded and heretofore carried on by the late Mr. Wm. Webster. To carry on the business of electrical engineers and contractors. Signatories (with 1 share each): Wm. Webster (electrician), 8, St. Martin's Place; T. Slater, 19, Great George Street; S. Owen, 19, Great George Street; C. C. Davies, The Cottage, Dane Park, Lee; E. Webster, Lee Terrace; O. March (electrical engineer), 53, Gratton Road, West Kensington; J. H. Crow, 8, St. Martin's Place, W.C. The signatories are to appoint the first directors. Qualification: £500 in shares. Remuneration: £100 per annum each, with an additional £150 for the chairman. Registered 9th inst. by Hargrove & Co., 3, Victoria Street, Westminster.

Schülcke Gas Lamp Company, Limited.—Capital: £50,000 in £1 shares. Objects: To carry out an agreement entered into with Messrs. Woodhouse and Rawson for acquiring the invention known as the Schülke lamp. Signatories (with 1 share each): G. H. Little, 32, College Buildings, Commercial Street, E.C.; Tom Rowe (electrician), 215, The Grove, Hammersmith; A. Bergthiel (electrician), 38, Warwick Road, Maida Vale; E. Ward, 55, Shelgate Road, Clapham; T. E. Marsh, 42, Reighton Road, Upper Clapton; W. R. King, 147, Boyson Road, Camberwell; A. Stoneham, Wanstead, Essex. Directors' qualification: 250 shares. The company in general meeting will determine remuneration. Registered 5th inst. by Ranger and Burton, 12, Idol Lane, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Union Electrical Power and Light Company, Limited.—An order of the Chancery Division of the High Court of Justice, dated 20th ult., and filed on the 10th inst., cites that upon the petition of R. E. Crompton & Co., of the Arc Works, Chelmsford, the Court directs that the company be wound up, and that the costs of the petitioners be taxed by the taxing master and paid out of the assets of the company.

Ashworth Brothers and Company, Limited.—The registered office of this company is situated at the Union Ironworks, Franklin Street, Rochdale Road, Manchester.

Protean Battery Syndicate, Limited.—The registered office of this company is at 119, Palmerston Buildings, Old Broad Street.

Maxim-Weston Electric Company, Limited.—The annual return of this company, made up to the 11th ult., was filed on the 1st inst. The nominal capital is £125,000, divided into 500,000 shares of 5s. each. 311,600 shares are allotted, upon which the full amount has been called. The calls paid amount to £78,000. The sum of £100 has been paid upon 400 forfeited shares.

CITY NOTES, REPORTS, MEETINGS, &c.

West India and Panama Telegraph Company, Limited.

AT Winchester House, Old Broad Street, on Wednesday, the twenty-second ordinary general meeting of the members of this company was held at noon, under the presidency of Mr. C. W. Earle (chairman of the directors).

The Secretary read the notice convening the meeting and the minutes of the last general meeting having been read, were confirmed and signed by the chairman.

The report, given in our last issue, was taken as read.

The Chairman said: Gentlemen, I suppose you will take the report and accounts as read. They refer to a half-year which, considering that it is the poorer half-year of the two, has been the most successful that we have ever had, except one in 1883. Most of you will know that the sugar crop matures in the first six months of the year. That creates a certain amount of telegraphic business in connection with it. Therefore our second half-year is generally not so successful in revenue as the first. They are both poor enough, Heaven knows. The gross revenue we receive per mile is not half what is received by other trans-Atlantic companies, which will show how badly off we are. In 1883, the year with which I am dealing, we had certain windfalls, as we have had in the last half-year. First, we had an increase in the traffic over the corresponding half-year; and secondly, we had an opportunity of engaging one of our ships to another company, and that relieves us from its maintenance. This last half-year a ship was away over 29 days. Besides these two circumstances there has been a profit on exchange, which generally speaking leans the other way, causing us a loss in bringing our money home from the West Indies; then there is the profit on the cable which we sold to the International Ocean Company; and then there is the saving of £250 in the debentures being issued at 5 per cent. instead of 6 per cent., which has come into effect in the last half-year. The conditions have combined to enable us to pay off some arrears. Thus we are in a very different position from 1883. Then our depreciation fund was in a very different condition to what it is now. In those days we were rather like what our country appears to be in regard to national defence—behindhand; and instead of giving a dividend to the first preference shares, we felt it our duty to put all into the reserve fund. In the present case our reserve fund is about level with the calculated depreciation for the year. With regard to the reserve fund, I may just as well point out that it is nearly fully invested in easily realised securities, and the market value of those securities is about £8,000 in excess of what it cost us to buy them. I am glad to report that the repair of the Jamaica-Porto Rico cable, which has cost us large sums in cable loan and the employment of ships for weeks and weeks, has been made. It is a most important cable, because the greater part of our revenue-producing field lies east of Porto Rico, and therefore until we had repaired this duplicate cable between Jamaica and Porto Rico we were depending solely upon one cable. I think, therefore, the money is well spent. When we wrote this report I was in hopes we were going for the first time to have a meeting with every cable in working order; but since then we have had the announcement of the failure of the St. Vincent-Barbados cable—a short cable but an important cable—which has several times been interrupted. The question of interruptions of our cables, where they are not duplicated, has and is likely to give us some trouble. The colonies are moving for duplicates, but I say in reply that with a system which has not paid any revenue, how can you ask us to throw more capital into the sea for the sake of making your communications more perfect? If we can make some modifications we shall be ready to meet the Colonies fully half way. But at present I should feel indisposed to sink more capital in so unremunerative an undertaking. I hope that policy will have the support of the meeting. With regard to the accounts, I do not think there is any necessity for me to take up any time. I shall be glad to answer any questions you care to put. I wish, however, to refer very briefly to the loss which I think we shall all feel—the loss of a very conspicuous member of the company—in the death of Mr. Abbott. He brought forward at the last meeting a very intelligent measure for the re-arrangement of our cables. I always found Mr. Abbot a very fair man to talk to, with the gift of a ready wit and a good power of debating; and, although he did not always agree with me, he took a very broad comprehensive view of every question raised. You know what has happened to the proposal; it was submitted to Sir Horace Davey and other leading lawyers, and was found to be perfectly impossible to carry out. We got Mr. Abbott to come into the board room to hear the result, and he at once bowed to the decision of superior authorities. I am sorry we shall never see him at our meetings. I beg to move; "That the directors' report and accounts up to 31st December, 1887, submitted to this meeting, be and the same are hereby received and adopted, and that, as recommended by the board, a payment of 10s. per share on account of arrears of dividend on the first preference shares be and the same is hereby declared."

Mr. William Ford (one of the directors) seconded the resolution.

Mr. Morten said that the accounts for the half-year scarcely gave a correct idea of the work of the year. The total revenue for the year had been about £96,200, and the expenses £50,400, thus leaving a net revenue of £45,890. That

would have been sufficient to pay the first preferences in full, the second in full, and leave something for the ordinary shares. He was certain his statement was correct and undeniable. With regard to Mr. Abbott's scheme, he thought very likely some things were overlooked in putting the case before Sir Horace Davey. The very scarcity of the attendance in the room showed the little interest taken in the company. And why? Because the second preference shareholders and ordinary shareholders had not received one penny. They had got no interest in the company. All their life and spirit was ground out of them. They had reserved £130,000, and the value of the securities was quite £10,000, not £8,000. (Chairman: £8,000. We take the average selling price. Some little disturbance.) He believed any board could remedy their grievances in a very few months. They could get a short Act of Parliament. If they were fairly treated, and arrears paid off, they would be able to sell their £10 shares at £5. He could afford to wait, but there were hundreds of poor shareholders who could not, and they were bound when they sold to sacrifice their capital for three shillings in the pound. There was no need for improvement; they were already in a state of prosperity, and if the board would only meet their views their company would rank as one of the commercial successes of London, instead of as one of the greatest failures. If their company was so very poor, why did they pay £2,000 yearly in directors' fees? He was one of the largest shareholders in the company. They gave the directors bread, and they returned them a stone. They did not mind giving £2,000 a year, but it was their duty to give them back something. He wished to move the following resolution:—"That until the arrears of dividend on first and second preferences had been paid off no further sums be added to the reserve fund, and that the directors be requested to confer with three of the larger shareholders as to the best course of paying off such arrears."

Mr. William Ford said that it was not competent to move such a resolution.

Mr. Morten said he moved it as an amendment to the report.

Mr. Firth said that he wanted to know whether they accurately understood their positions as ordinary shareholders. He thought there was some strength in the argument that the reserve fund had arrived at a place where it could stop for some time. It should, however, be at the discretion of the directors. He understood they were making £40,000 a year. It seemed that the preferences struck off £33,520. Therefore there was £17,000 a year available for the purpose of paying off the remaining liability, and then paying a dividend to ordinary shareholders. He understood they were in a sound position. They only owed £53,000 with respect to back dividends. He would like to ask, if the present rate of profit were continued, might they look forward in two or three years to receive that £17,000 a year? If so, they might look forward to the future with satisfaction. He thought the board was doing its best for the company. He wished to know: (1) Whether in the judgment of the directors the reserve fund was not high enough; and, (2), whether they might as ordinary shareholders look forward to having a dividend of 3 or 4 per cent. in two or three years time.

A Shareholder, declaring that he had held shares for ten years and owned a thousand shares, said that he had received £20. Might it not be advisable to pay off a dividend out of the investments?

The Chairman enquired what would become of the reserve, and what would there be for depreciation. It was the right thing in a company employing a depreciating plant to set aside some sum. That was the real crux of the question. They had cables which had been down 17 years. A certain depreciation must take place every year, and they took a liberal view of the matter. The calculation they had made for depreciation was now about the same as the reserve fund. But next year they would have to add to the reserve fund because further depreciation would have taken place. The mistake was that it was called a reserve fund; a renewal fund would have been better. It was only what should properly be written off before they talked about profits. They must first of all write depreciation off their plant.

Mr. Morten wished to know if it was a fact that they had doubled nearly all the cables, and was answered in the negative.

Mr. J. G. Griffiths (auditor of the company) declared that as Mr. Morten persisted in his accusations he would say that he knew he was wrong. The board were in a place of responsibility to the shareholders, and were bound to make these reserves. It was a personal responsibility and he thought a great responsibility. The duplications of the cables had been made out of the capital. He thought that entirely disposed of the point.

Mr. Morten asked how the cables had been reduplicated out of the capital. Their debentures were £50,000. Could they duplicate the system for that sum?

Thr Chairman said that they paid for the reduplication by issuing shares.

The Auditor supported this statement, and said that about £500,000 would be needed to duplicate all the cables.

Mr. Morten then declared that the directors had no right to draw £2,000 yearly.

Mr. Guesdon said that he regretted that all these questions turned upon the reserve funds. It was indispensable that every company should have a solid backbone so as to claim the confidence of the public. It was nonsense for them to grumble. He had held ordinary shares for 15 years, but as a business man, he said, must not complain. The shareholder's place was to take his share of the profits of a good business, and to submit in silence if the business was unsuccessful. It was useless to complain of the reserve fund unless they thought the directors were accumulating more than was necessary. It could not exactly be called a depreciation fund; on ships they could find the depreciation, but on cables under the sea it was impossible. That was a problem yet to be solved. But, for a company like theirs, which had a large extent of unfavourable ground, to be wanting in the power to relay its cables, was to depend solely upon subsidies. But he regretted that the preference shares were to be paid first, and thought it was not creditable to the City of London that such a scheme existed. He would ask at what rate they insured the cables. (Chairman: 6 to 7 guineas each.) He would suggest that that was an unprofitable investment. (Director: Where should we have been if we had not insured the *Investigator*?) They could protect anything if they were willing to pay for it, but he thought insurance was a poor way of protection. As to the reserve fund, he would remark that it was a distinct fund and had no right to be interfered with. It was set apart properly as a renewal fund, and should be touched for nothing else. It could not be introduced as a normal element of profit. He hoped the board would not interfere with it. He would also ask what were the advantages in the cable contract. He had never heard the advantages they derived in accepting the one fulfilled.

The Chairman said that, of course, they took the best tender. There was not a great difference between the lowest and the highest. It was unfair to name the companies.

Mr. William Ford said that at the office the information could be easily obtained.

Mr. Guesdon said that he really did not want to press the question to put the directors in a difficulty. The securities were improving, and he hoped the shareholders would accept the situation and submit to the inevitable. When the directors felt they could fairly apportion some of the profits to them, he knew they would.

The Chairman said that they were doing so at the present moment.

A Shareholder said he could sympathise with the arguments of the ordinary shareholders, since he held both first and second preferences. The first holders might be grateful for what they got, but the others must hold the property as most unremunerative. As regarded the reserve fund, he thought it was necessary that they should have a certain amount of ready money with which to repair any fault.

Mr. Morten said that he did not advocate the reduction of the reserve fund, but putting no more to the reserve till they had paid the preference shares.

A Shareholder said that they must remember that year by year the cables had depreciated, and if that depreciation resulted in breakages the expenses must be met by the reserve. He thought it should be maintained as far as was necessary to working the company profitably. If not, the directors might be brought to law. As to the reduction of the directors' fees, he was not very strong in favour of that, as a preference shareholder; but if he held ordinary shares he should be of opinion that the directors should show great economy and try to reduce the cost of everything. The other remedy suggested was one on which he thought they might be better agreed, and one worthy of consideration. If the preference shareholders were willing that their arrears should be postponed, let the money be distributed among the larger portion. At the last meeting he thought they were unanimous in favour of Mr. Abbott's scheme. The only thing was it could not be carried by legal process, but he thought there was nothing which prevented them from applying for an Act of Parliament. Of the three remedies proposed, he was in favour of the last. Possibly their company would be able to clear off the arrears of the first class, but they could hardly expect to clear off the second. They would be glad to be told what might be anticipated for the present six months. Four months and a fortnight had elapsed, and possibly some reasonable view of the future might be given. If the directors said that business had been as good, and expenses as small, so that they might anticipate an equally good dividend for the 1st June, he would advise the shareholders to submit; otherwise, he thought there was great force in the view of keeping up the question of an Act of Parliament.

Mr. Guesdon hoped the directors would correct the opinion that the vote at the last meeting was unanimous.

Another Shareholder asked if income tax was paid upon the amount carried to the reserve fund. He also suggested that the revenues of the corresponding half-year should be shown in the directors' reports. The company owed the preference shareholders a certain sum. In four years at the present rate that would be cleared off. Let the preference holders be deferred for 10 years.

Another Shareholder said that they could not be surprised that the poor ordinary people were given to raising objections. He believed the directors had done their best, and if they could pay the shareholders they would not have to ask it. The ordinary shareholders could well say that their interests were always forgotten.

Another Shareholder would like to know what the reserve fund should be before it was closed.

Another Shareholder said that if they looked at the standing armies of Europe they would obtain a forcible illustration of the ever-changing necessity for something in reserve.

The Chairman said that the reserve fund ought in fulness of time to be at such a figure as to enable them to entirely relay the system. They had calculated always upon the cables lasting longer than any ever had lasted.

A Shareholder wished to correct the evident impression that the

reserve fund was increasing. Such was not the case, but the opposite.

The Chairman then answered a few of the questions raised. With regard to the unanimity of the shareholders at the last meeting, that was much too favourable a view taken. They had talked about Bills in Parliament. They must have the practical consent of all their constituents, or they would not be justified in incurring the expense. They did not pay income tax on the reserve. In concluding, he put the resolution to the meeting, and it was carried, five voting to the contrary.

A Shareholder asked if the Halifax to Bermuda cable would have any influence on the company, and was answered in the negative.

Another Shareholder asked what had been the business during the four months of the present year, and was informed that there was a slight increase.

Mr. Earle having vacated the chair, Mr. William Ford took it and proposed "that Mr. Charles William Earle be and hereby is re-appointed a director of the Company."

Sir James Anderson seconded the resolution, which was carried with one dissentient, and briefly acknowledged by Mr. Earle, who then re-took the chair.

The Chairman moved the re-appointment of Mr. William Ford as a director.

Mr. William Andrews seconded, and the resolution was carried with two dissentients.

Mr. John George Griffiths was unanimously re-appointed auditor, upon the motion of Mr. Cuff, seconded by another shareholder.

A vote of thanks to the chairman was unanimously carried, and acknowledged by the chairman.

Woodhouse and Rawson, Limited.

ON Tuesday, Lieut.-General Sir John Stokes, K.C.B., R.E. (one of the directors), presided in Cannon Street Hotel over a special meeting of the shareholders of this company, with the object of the board announcing the interim dividend, and explaining the steps which it was proposed to take in view of the increased business. An interim balance sheet was distributed in the room as follows :—

Dr. INTERIM BALANCE SHEET AT 31ST DECEMBER, 1887. *Cr.*

Capital and Liabilities.

To Nominal Capital—			£	s.	d.	£ s. d.
39,980 ordinary shares of £5 each			199,900	0	0	
100 founders' shares of £1 each			100	0	0	
			200,000	0	0	
„ Share Capital Subscribed—						
14,100 shares of £5 each on which 35s. per share has been called up...	£24,675	0 0				
6,900 shares of £5 each allotted to vendors as fully paid up	34,500	0 0				
100 founders' shares of £1 each	100	0 0				
			59,275	0	0	
Deduct calls in arrear, *less* amount paid in advance...			1,820	15	0	
						57,454 5 0
„ Sundry Creditors—						
On open account			1,689	11	11	
On bills payable			1,805	10	11	
Loan from bankers (secured)			9,000	0	0	
						12,495 2 10
„ Paris Account Reserve						1,196 1 2
„ Profit and Loss Account—						
Balance thereof transferred hereto						11,668 9 8
						£82,813 18 8

Assets.

By Cash—			£	s.	d.	£ s. d.
At bankers			691	2	7	
In hand			77	16	1	
						768 18 8
„ Sundry Debtors — including balances due from subsidiary companies—						
Guaranteed by vendors ...			10,511	15	8	
For which the company hold security			13,128	19	5	
On open account including agencies			7,000	16	0	
						30,641 11 1
„ Outlay on Installations in Progress						1,529 8 2
„ Shares in Subsidiary Companies			37,790	0	0	
Less reserve thereon			5,290	0	0	
						34,500 0 0
„ Shares in the Universal Automatic Machine Company, Ld.—						
19,127 shares of £1 each ...			19,127	0	0	
Less reserve thereon	£2,869	0 0				
Allowance to meet a claim of subsidiary company, since agreed ...	1,500	0 0				
			4,369	0	0	
						14,758 0 0
„ Office Furniture and Battery ...						428 3 7
„ Stores and Tools at Office ...						87 17 2
„ Goodwill and Patents—						
Represented by 100 founders' shares						100 0 0
						£82,813 18 8

We have examined the foregoing balance sheet and compared it with the books and vouchers of the company, and certify the same to be correct. We refer to our report to the directors of this date.

76, Coleman Street, E.C., 11*th May*, 1888. (Signed) SPAIN BROTHERS & Co., *Chartered Accountants.*

The Secretary read the notice convening the meeting.

The Chairman said: Gentlemen, it was competent for your board to declare an interim dividend and to make a further issue of shares without convening you in a general meeting, but the board have considered it more fitting, whilst making known to you the amount of interim dividend which they find themselves able to announce, to accompany it by a balance sheet for your information which will justify our decision and enable you to form an opinion on the position of the company. We have much satisfaction in announcing that the first half year's working has given a profit of over 40 per cent. per annum, but we do not propose to declare an interim dividend of more than 12 per cent. per annum on the amounts paid up, or credited as paid up, on the several shares. We think it more prudent to carry the remainder—a sum of more than £8,000—to the current half year, especially as it consists principally of shares in other companies which are growing in value, and which it is therefore better to retain than to sell them now in order to declare a high interim dividend. The board have been fortunate enough to acquire, since the formation of the company, some valuable patents at a mere nominal price, for which a very large return may be shortly expected; indeed a license for one application only in three different countries had been provisionally disposed of for over £4,000 and a royalty—a deposit having been paid for the same—but unfortunately the purchasers, from reasons quite independent of the patents, were unable to complete their arrangements and forfeited the amount paid on deposit. As I have just now said, part of our profits consists of fully paid up shares which we hold in the Universal Automatic Machines Company, partly in payment for patents that we sold to the company and partly in payment for work done for them. We instructed our auditors to value these shares and to employ a professional man accustomed to valuations of this kind. He valued the shares at par, but we have only taken into account 85 per cent. of their par value, being the price at which a large number have lately changed hands. These shares were acquired shortly after the formation of the company, and at the time the balance sheet was taken, 31st December, 1887, they were only worth about half their present value; at about that time we had an offer for them at that price. We refused, however, to sell, believing that the shares would rise considerably over par, and we preferred to borrow money from our bankers for the increase in our business. It was well we did so, for we have lately sold some at only 15 per cent. discount, and we hope before the end of the year to see their value much enhanced. We consider, therefore, our valuation of them in the balance sheet as fully warranted. As you will see by the balance sheet, the actual amount of working capital put into the business on its being turned into a limited company is only £2,855. We considered it advisable at the formation of the company to begin with a small capital and show what we could do, gradually extending the business as we saw fit, the interest paid for advances from the bankers being nominal in comparison with the profit made. As regards the increase of capital which we propose to make to further develop and push the business of the company, I may mention that large contracts for lighting, the pushing of patents abroad, and the manufacture of plant at home, require that we lie out of our capital for considerable periods, although we make large profits for giving such facilities. Up to the present we have taken advances from the bank on account of our increase in business, and have now come to the resolution to issue 6,000 of the ordinary shares on which we only propose to call up the same amount as has been called up on the first issue, namely, 35s. per share by the 1st of

July, which will provide £10,500, and £30,000 in 6 per cent. first mortgage debentures of £100 each, of which £15,000 will be taken up by the 1st of July, the remainder by the end of the year. With this increased capital we confidently expect to show you even more brilliant results in the second year of our existence than in the first. The present shareholders have a prior right to the shares now issued in the same proportion as they at present hold. We are much pleased to be able to announce that very important negotiations which have extended over many months, and which will lead to a very great and lucrative extension of our business have been brought to a satisfactory conclusion, but I cannot give you details of this transaction, as there are heavy interests involved which cannot now be divulged.

Mr. Hayes (a shareholder) asked if this second issue meant that all the shares were not taken up in the first issue.

The Chairman said that they were not issued in the first instance. Only 14,000 were then placed at the disposal of the public, and they reserved a certain amount to meet any requirement.

Mr. Hayes asked if that meeting decided the issue of the new shares.

The Chairman said that the board was quite able to have issued the shares without making any explanation, but they thought that it would be gratifying to the shareholders to be told before they did so.

Mr. Hayes supposed that the dividend of 12 per cent. per annum was declared.

The Chairman said that it was so.

Mr. Hayes said that he should have great pleasure in proposing that the best thanks of the meeting be given to the chairman for presiding. He considered the statement which had been presented very satisfactory.

Mr. Philip Rawson seconded the vote of thanks, which was unanimously accorded.

The Chairman, in replying, said that it was a great pleasure to him to be able to announce what he had had to say to them. He then declared the business of the meeting ended.

The London Platino-Brazilian Telegraph Company.

THE tenth ordinary general meeting of the shareholders of this company was held last Friday at Winchester House, Old Broad Street. The report stated that the interim dividend of 2s. 6d. per share, paid on the 22nd November last, absorbed £4,793 10s., leaving £7,675 11s., from which the directors proposed to appropriate £150 in further reduction of expenses of issue of the 6 per cent. debentures, to add £1,000 to the reserve fund, and to apply £5,752 4s. in payment of a final dividend of 3s. per share, making, with the interim dividend already paid, a distribution at the rate of 2¾ per cent. per annum (as against 3 per cent. paid last year); leaving a balance of £773 7s. to be carried forward. Sir John Pender presided, and said that on the last occasion of addressing them he had stated that negotiations were going on with the Brazilian Government, and also the Western Brazilian Company, with the view of taking over the management of the affairs of their own company. These negotiations had been concluded and meetings had been held, at which the resolutions passed had been confirmed. It had been unanimously agreed that the management of the company should be placed in the hands of the Western Brazilian Company upon certain conditions. Their company was doing a steady and progressive business, as during the past year the cables had earned considerably more than in the previous year. At the same time the Western Brazilian was equally progressive, and was a larger system than their own. The board were, therefore, about to retire, and to hand the company over in a highly satisfactory state. If it went back under the new management, which there was no reason to believe it would do, there were members of their company who also belonged to the other, and who would be able to ask the reason why. The change would result in the increase of the dividend by about 1 per cent. The motion was adopted.

Hastings and St. Leonard's Electric Light Company, Limited.

THE directors' report for the year ending March 31st, 1888, states that the company is now supplying 30 arc and 864 incandescent lamps, as against 30 arcs and 704 incandescent lamps last year, again showing an increasing business. The directors have every reason to believe that by laying down mains in new directions and increasing the plant, the demand for supply of electric light will enormously increase. The principal hotels are now lighted by electricity with very satisfactory results, and applications are being made to substitute incandescent lighting for gas in places of worship and business establishments. On referring to the profit and loss account, it will be seen that the gross profit for the year amounts to £558 18s. 1d., but from this must be deducted interest on overdraft at bankers and on debenture bonds, issued to the amount of £1,000, thus leaving a balance of £314 9s. 4d., out of which the directors propose paying a dividend of £3 per cent. free of income tax, amounting to £204 10s., and carrying forward the balance to next year's account. The suggestion of the directors at the last annual meeting of the shareholders, as to raising a sum of £5,000 by means of debenture bonds, was not carried out, but a sufficient number of shareholders were found willing to take up bonds to the amount of £1,000, bearing interest at 5 per cent. per annum. The company's bankers, Messrs. Beeching & Co., kindly agreed to reduce the rate of interest on overdraft to £5 per cent. The revenue account shows that a sum of £166 6s. 3d. has been charged to that account for repairs to boilers, including a new fire-box put in by Messrs. Robey & Co., of Lincoln.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 11th, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,561.

The Great Northern Telegraph Company, Limited. The receipts for April, 1888, £21,400; January 1st to 30th April, 1888, £75,200; corresponding months, 1887, £81,520; and of 1886, £78,480.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending May 11th amounted to £4,312.

NEW PATENTS—1888.

1851A. "A sound-conveying tube for telephones, graphophones, and like instruments." J. Y. JOHNSON. (Communicated by the Volta Graphophone Company, Incorporated, United States.) Dated February 7. (*Complete.*)

6657. "Improvements in secondary batteries or electric accumulators." B. D. WILLIAMS. Dated May 4.

6680. "Improvements in electric railways." G. E. VAUGHAN. (Communicated by S. Trott, Nova Scotia.) Dated May 4.

6740. "An improved portable electric lamp." J. T. ARMSTRONG and A. SERRAILLIER. Dated May 5.

6772. "Improvements in electrical measuring, testing, and other apparatus." T. CALLIPHRONAS. Dated May 7.

6828. "An instrument to be called the 'automatic telautograph.'" F. T. TOLEHARD. Dated May 8.

6834. "An instrument for the measurement of the coefficients of electro-magnetic induction." A. P. CHATTOCK. Dated May 8.

6836. "An electro-dynamic relay for constant or varying currents." W. E. AYRTON, J. PERRY and D. COOK. Dated May 8.

6876. "Improvements in apparatus for measuring electric currents." H. ARON. Dated May 8.

6889. "Improvements in dynamos and motors." O. FIRTH and E. W. CRABTREE. Dated May 9.

6893. "Improvements in electro-magnetic and magneto-electric generators." E. C. WALKER. Dated May 9.

6907. "Improvements in storage batteries." M. IMMISCH. Dated May 9.

6909. "Apparatus for use with dynamo machines." E. J. HOUGHTON. Dated May 9.

6910. "A system of electric lighting." E. J. HOUGHTON. Dated May 9.

6927. "Improvements in electrically propelled vehicles, and appliances connected therewith." M. R. WARD. Dated May 9.

6928. "Improvements in electric switches." F. V. ANDERSEN and J. F. TAFE. Dated May 9.

6953. "Improvements in electric gas-lighters." W. SOUTHERN. Dated May 9.

6961. "Improvements in automatic electric batteries." G. A. NUSSBAUM. Dated May 10.

6985. "Improved switch for electrical tramcars." M. IMMISCH. Dated May 10.

6988. "Improvements in the method and means of supplying electrically-worked vehicles with fresh sets of accumulators or equivalent sources of electricity." M. R. WARD. Dated May 10.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

747. "Means or apparatus to be employed in the application of electricity to propel vehicles on roads with or without tram or other rails." F. WYNNE. Dated January 17. 8d. Relates to the developement of former inventions of the inventor according to which vehicles can be propelled along roads (provided or not with rails for the vehicle to travel upon) by means of electricity actuating a motor or motors carried by the vehicle propelled, and which is, or are introduced into a circuit that is progressively closed as the vehicle proceeds. The claims are 6 in number.

949. "An electrical switch or circuit closing and interrupting device of improved construction." G. PERCIVAL. Dated January 21. 8d. Consists of an arrangement of two or more inclined surfaces and one or more springs so placed in relation to one another, that the springs always tend to press towards one or other of the inclined surfaces, so that if pieces of metal be interposed between the spring or springs, and the inclined surfaces, the piece or pieces of metal so interposed will be kept in contact with the inclined surface or surfaces in such a manner that on a relative motion being imparted to the spring or springs and

incline or inclines, the piece or pieces of metal, resting on the incline or inclines, shall be caused to move up or down the said incline or inclines according to the direction of the relative motion. The claims are 3 in number.

2419. "Improvements in dynamo-electric machines." F. BOSSHARDT. Dated Februry 16. 8d. Claim:—In dynamo-electric machines in which the electro-magnets are made to revolve in a direction opposite to the armature, the application of a pair of cones on which revolves a pulley or strap, under the control of a governor or galvanometer, substantially as and for the purpose specified.

3878. "Improvements in or connected with electric alarm clocks." H. BOARDMAN. Dated March 15. 8d. Consists of the combination with a time piece or clock of novel means or arrangements for connecting and breaking the circuit of one or more electric bells situated at the place or places where it is necessary the alarm should sound. The claims are 4 in number.

3943. "Improved instruments for measuring electric currents." W. H. DOUGLAS. Dated March 16. 8d. The inventor employs a solenoid and a core similar to the regulator in an arc lamp. The movement of the core is used to move a curb so as to shorten or lengthen the spring of a pendulum or the regulating spring of a balance of a timepiece in the following manner. The current passing in the solenoid attracting the core is proportional to its quantity of current. This is made to accelerate or retard a timepiece as follows. The core of the solenoid is attached to the curb or regulator of the timepiece, the curb moving up and down the suspension spring of the pendulum in sympathy with the variation of the current passing through the solenoid, and actuating the core, accelerates or retards the timepiece in proportion to the movement of the core. The claims are 2 in number.

4138. "Improvements in safety devices in electric circuits." A. C. COCKBURN. Dated March 19. 8d. Relates to the fuses described in the No. of the REVIEW for February 10th. The claims are 3 in number.

4546. "Improvements in dynamo-electrical machines in combination with motor engines." C. D. ABEL. (Communicated from abroad by Siemens and Halske, of Berlin.) Dated March 23. 8d. Claims:—1. The combination of a dynamo-electric machine with a motor engine in such a manner that the revolving armature is carried by the engine shaft, or by an extension thereof, while the field magnets are carried either directly or indirectly by the framing of the engine, substantially as described. 2. In combined motor engines and dynamo-electric machines such as are referred to in the preceding claim mounting the armature upon an overhanging end of the engine shaft, substantially as described.

4553. "Improvements in electric telegraph apparatus." W. DICKENSON. Dated March 26. 11d. Claims:—1. In syphon recording instruments the use of permanent horse-shoe magnets laid horizontally one over the other, and formed substantially as described, for forming the magnetic field in which the swinging coil oscillates whereby a powerful magnetic field is obtained, with the magnet occupying but little space. 2. The iron core capable of being moved into or from the interior of the swinging coil. 3. The construction of recording electric telegraph apparatus, substantially as, and illustrated in the drawings annexed.

4914. "Improvements in switches for making and breaking electric circuits." R. D. SMILLIE. Dated April 2. 8d. Has for its object the construction of switches for electric circuits in an improved manner, and so that they cannot be left incompletely adjusted. The claims are 4 in number.

7530. "Improvements in electrical transformers." J. G. STATTER. Dated May 25. 8d. Claims:—1. The improvement in electrical transformers consisting in the employment of simple E-shaped plates, substantially as set forth. 2. The improvement in electrical transformers consisting in the employment of compound plates, substantially as set forth. 3. The respective improvements in electrical transformers consisting in the several specific forms of plate shown.

8329. "Improvements in electrical signalling apparatus for railways." W. E. LANGDON. Dated June 10. 8d. Consists in the combination of certain parts of telephonic apparatus employed for the purpose of conveying speech or other signals from one point to another with certain parts of electrical bells employed for block signalling purposes on railways, in such a manner that the combined instrument or instruments may be employed upon the same wire which is used for the block signalling bell. In order to effect this, the inventor winds the coils of the electro-magnet of the bell instrument with a "secondary" wire, and he employs it when using the telephone communication in place of the "induction" coil specially provided for that purpose in ordinary telephone instruments for producing the "induced" current, and he arranges the connections between these parts and other parts of the portions of the two instruments in such a manner that when the telephone is in a certain position—say its position of rest—the secondary circuit of the said electro-magnet shall be interrupted, and the main line wire shall be placed in circuit with the primary wire and such other parts of the bell signalling instrument as shall enable signalling by the bell alone to be conducted in the ordinary course, and that when the telephone is removed from the said position of rest, the "primary" coil sball be placed in circuit with the local battery and telephone transmitter portion of the apparatus and the "secondary" wire connected through to the main line wire and earth, so that the block signalling bell may be cut out of circuit, and telephonic communication carried on upon the same wire as that employed for the block bell signalling. The claims are 3 in number.

11923. "Improvements relating to the manufacture of plates or electrodes for primary or secondary electric batteries and to apparatus therefor." C. L. R. E. MENGES. Dated February 19. 8d. Claims:—1. As a support for the active material in primary or secondary electric batteries, a plate in the form of trellis work the cells of which have sides in the shape of gutters so placed that the lines of intersection of the parts of the trellis work which cross each other form groups of parallel lines so as to permit the moulding of the model, or the removal of the casting from the mould in the direction of these lines. 2. For the removal of the plates hereinbefore described from a mould of metal or other material, the employment of mechanism which permits the parts of the mould to be moved parallel to each other in two different directions, in such a manner that during the first movement one of the parts of the mould is lifted from the cast plate, whilst during the second movement the cast plate remains in this part and is removed from the other part of the mould.

14768. "Improvements in the construction of switches for the making and breaking of circuits conveying electric currents." C. M. DORMAN and R. A. SMITH. Dated October 31. 8d. Claim:—1. In a switch of the rotary type, the case of which is made of eathenware or other incombustible non-conductor of electricity the method of allowing the handle to take its bearing in the cover of the switch and transmitting the rotary motion from the handle to the mechanism of the switch by means of a crank pin and slot, or two crank pins and drag link, or by means of a projection or projections on the handle gearing loosely with the mechanism of the switch, or a projection or projections on the mechanism gearing loosely with the handle, or by means of an intermediate piece or pieces gearing loosely with both handle and mechanism, or by means of a flexible shaft or coupling, in such a manner that the handle may revolve freely even if the axes of the handle and mechanism do not perfectly coincide.

15858. "Improvements in dynamo-electric machines and electro-motors." W. MAIN. Dated November 18. 1s. 1d. Relates to dynamo-electric or magneto-electric machines for generating alternating or continuous currents, and to electro-motors. Its objects are to combine the utmost efficiency with the least weight and the greatest compactness that are practically possible in such machines. The claims are 15 in number.

16032. "Improvements in electro-motors and dynamo-electric machines." W. MAIN. Dated November 22. 11d. Relates chiefly to electro-motors, but it is also applicable to dynamo-electric or magneto-electric generators. Its objects are to combine the utmost efficiency with the least weight and the greatest compactness that are practically possible in such machines The claims are 14 in number.

16351. "Improvements in electric belts." A. OWEN. Dated November 28. 8d. Consists in attaching the discs or electrodes so that they can be adjusted upon the belt to apply the current at any desired point or points; in the means for reversing the current, so that either the positive or the negative electrode can be applied: in the means for connecting the conductor cord with the battery, and for adjusting it thereupon; in making the battery case adjustable upon the belt, so that the battery can be arranged in various positions upon the person; in the mode of connecting the conductor cord with two or more discs or electrodes, and in the construction and combination of the elements of the battery. The claims are 8 in number.

16376. "Improvements in electric arc lamps." C. B. NOBLE and R. D. NOBLE. Dated November 29. 8d. Consists in providing improved means for automatically throwing the current from one set of carbons to another, when the former has been nearly or quite consumed. It also consists in furnishing an improved cut-out, and relates to other details of construction. The claims are 3 in number.

16424. "Improvements in telegraphic instruments." W. P. THOMPSON. (A communication from abroad by C. G. Burke, of America.) Dated Nov. 29. 8d. A coil or solenoid of insulated wire is placed in the circuit of the line, and there is provided for the solenoid an intense magnetic field consisting of two opposite magnetic poles derived from one or more electro-magnets. One of the poles of the magnet encircles one end of the solenoid, while the other pole extends within the other end of the solenoid. The two poles combine in their action to move the solenoid in one direction or the other according to the character of the current transmitted. The movements of the solenoid may be employed for operating a siphon of the character usually employed in telegraphic cable systems, or they may operate a circuit controlling device adapted to open and close the connections of an independent circuit, and thus operate a recording instrument or sounder of any suitable character. The claims are 5 in number.

16558. "Improvements in apparatus for measuring and regulating electric currents." A. WRIGHT. Dated December 2. 6d. Claims:—1. The described improvements in apparatus for measuring electrical currents, consisting in the method of arranging and disposing a series of conductors so as to obtain a long range of motion for a point in the series, by the summation of the movements due to expansion or sag of such conductors when heated, which motion may be applied, substantially as and for the purposes set forth. 2. In apparatus for regulating electrical currents the

combination of the described method of obtaining a long range of motion, with the means of regulating by introducing a resistance, substantially as and for the purposes set forth.

16669. "An improved secondary battery combined with a miner's lamp." M. BAILEY and J. WARNER. Dated Dec. 3. 6d. Claims:—1. An improved secondary battery constructed, chemically formed, and connected to an incandescent lamp suitable for mining or other purposes substantially as set forth. 2. The methods of constructing the elements employed in the above combination by means of wire consisting of lead woven into a ribbon, mat, or mesh, having a bound edge or selvege, said elements being formed upon the Planté system in the manner deseribed. 3. In an improved secondary battery combined with a lamp as described, the method of suspending the elements so as to avoid all joints and connections, and so that one and the same element is an anode in one cell, but cathode in the contiguous one, the arrangement described also assisting to hold contiguous cells in contact, as set forth.

17157. "Improvements in galvanic batteries." H. H. LAKE. (Communicated from abroad by J. O. Whitten, of America.) Dated December 13. 6d. Relates to that class of galvanic batteries which are provided with reinforcing or feeding cups; and it consists in the certain novel features, the object being to produce a simpler, cheaper, and more effective device of this character than is now in ordinary use. The claims are 4 in number.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this society was held on Thursday, May 10th, Mr. E. GRAVES, president, in the chair. The usual formal business having been transacted, a paper was read by Mr. W. H. PREECE, F.R.S., on "Fire Risks and Fire Risk Rules."

The electric light, said Mr. Preece, cannot be held to be free from danger, but it was perfectly safe if properly dealt with, and the question to be decided was how it could be rendered least harmful. He had drawn attention to the risks in a letter to the *Times* written in 1880. In all systems where the greatest danger existed the elements of the greatest safety also existed, as proper precautions to avoid the dangers were taken. Are rules and regulations necessary? The use of a candle involved danger, but there were no regulations issued that a candle was not to be burnt at both ends at the same time. No rules, in fact, were necessary for self-evident dangers. A friend of his living near his own house at Wimbledon had refused to have the electric light on the score of expense, but the folly of this was shown by a gas explosion which took place, and which caused more damage than the fitting up of an electric light plant would have cost. The need of rules as regards electric lighting was great, since electric lighting systems were singularly open to fraud in consequence of the public being ignorant of the principles of the system, so that cheap-jackism was rampant; rules were therefore necessary to protect users. In 1881 the American Edison Company issued a series of rules and the Fire Insurance Board followed their example. In 1882 these rules formed the basis of the rules compiled by Mr. Musgrave Heaphy; these latter contained many Americanisms, notably the use of the word "ground" instead of "earth." The Franklin Institute had also issued rules; those of Mr. Heaphy, however, had practically formed the basis of all. The Society had drawn up a set of rules and three independent insurance offices had done the same. In America the rules drawn up by the New York Board of Fire Underwriters had been revised from time to time and met every requirement, but practically every town had now its own set of rules. In the spring of last year it was suggested that the rules of the Society should be revised, some thousands of copies of the original rules having being disposed of; as a matter of fact there had been more installations put up under these rules than under any others, except in London, where Mr. Heaphy's rules were predominant. He did not personally agree that any changes were required. It was first decided that the various fire offices should be communicated with to ascertain their views of the subject, with the result that it was considered desirable to make a change; it was also considered advisable to get Mr. Heaphy to work with the committee. Many meetings were held and everything went well, but eventually there was a serious disagreement between the committee and Mr. Heaphy; the objections, however, were as to phraseology only. Mr. Heaphy required that it should be definitely stated that certain rules drawn up by him for the Phœnix Fire Office were approved of by the Society, but this was decisively rejected. After an interval the meeting assembled again, and in January the rules were issued to which however certain offices object. The general question is entirely between insurer's and the insured; the Society can only act as advisers in the matter, and cannot be dictatorial. A great many difficulties arose in drawing up the rules, owing, as is usual in such cases, to the number of amendments proposed. The accidents which caused fires were very numerous, and he had before him several specimens showing this; one was a switch taken from the Houses of Parliament, another a piece of troughing. The actual amount of serious damage which had taken place was, after all, very small, and could not bear comparison with the damage caused by fires resulting from the usual causes. It was a most mischievous practice to bed wires in cement, and great damage resulted from the action of moisture in houses; gutta percha under water was indestructible, but when exposed to alternate wet and dry, it decayed rapidly and caused faults. It was very doubtful if wooden casing was really safe, especially if it was liable to get moist. Another great cause of danger was the use of mercury; he had never known a case in which a mercury contact had not caused mischief, and he had known a case in which it had caused a fire. Another great incentive to fire was the temptation to increase the size of an installation without increasing the size of the original mains, so that the latter had to carry more current than they were designed for. Bad joints were a most fruitful source of danger; it was stated however in the Boston rules that soldered joints were desirable, though not absolutely necessary—a most fatal rule in his opinion. With regard to the flux used rosin was the best, though a liquid flux enabled the soldering to be more easily effected; the joint in this case required to be carefully washed. The great essential however was that a joint, however made, ought to be a perfect one. He knew of an installation in which there had been 6,000 faulty connections. Cut-outs were a cause of danger rather than safety, unless well looked after. As regards an insulating medium for the wires, this ought to be non-inflammable; nearly all insulators hitherto used for covering wires were inflammable, except that used in the lead covered cables of Waring, which had been largely used by the Westinghouse Company; the material was a distillation of petroleum oil, and would not burn. Many of the criticisms which had been passed on the society's rules were, he considered, very absurd; some of the rules which had been most severely handled had been passed by a very large majority of the committee. The Phœnix Office rules were very good at the time they were brought out. Personally he would like the work of the society to be continued, and their rules to be generally accepted. Rule 32, with reference to volt power, was simply meant to define what is high and what is low tension, all potentials over 200 volts being taken to be high potential. He thought the rules drawn up by the Westminster and Guardian offices a disgrace. Rules were very useful, but they were of no value unless the work executed was properly designed and carried out by proper contractors and properly inspected. With reference to the use of joints, he would mention that in the Whitehall installation being put up by Mr. Gordon, there were no joints made, the wires being all cut to the exact length required. The rule that the leakage should not exceed $\frac{1}{1000}$th part of the whole, was better than to specify so many megohms per mile. The last precaution which ought to be taken was the proper education of our coming engineers. In conclusion he would state that the chief element of danger was the enormous competition which resulted in a great deal of jerry work being done; he believed that if the rules of the society are followed, there will be no chance of any fires taking place.

In the discussion which followed the reading of the paper,

Mr. MUSGRAVE HEAPHY said it was not his intention to say anything except to thank Mr. Preece for the way in which he had spoken of him. The disagreement of the committee which had been spoken of had reference to one word only, namely, "Phœnix"; he would at the adjourned discussion make a statement which would put a very different colour on the subject to that which Mr. Preece had given. As regards transformers, this question had come before the Phœnix Office, and it had been decided that transformers and high tension currents might be introduced *inside* buildings with proper precautions; he had never heard of any damage caused by their use.

Mr. KILLINGWORTH HEDGES could not understand why the Phœnix rules had "copyright" attached to them. In 1882, Mr. T. Bolas had read a paper before the Society of Arts on the subject of fire risks, and in the discussion Mr. Heaphy brought out his rules: these were identical with those compiled by Mr. Woodbury in America a year before; he submitted, therefore, that there could be no copyright. He would like to see one universal set of rules adopted.

Mr. HUMAN, the author of the Guardian Fire Office rules, said that whatever merit or demerit might be attached to the same, they were brought out for a specific purpose; people expected that each office should have their own rules and not those of others; at the time the Guardian rules were drawn up, the Society's rules were not in existence. Personally, he would prefer one universal set.

Mr. SWAN thought that Mr. Preece had done a great service in speaking of the fire risks of electric lighting, and that all he had said was quite necessary. Ignorance had been spoken of as a source of danger, but inexperience was equally dangerous; he could call to mind an installation reported upon favourably by an electrician of great eminence, but in which moisture had caused short circuits; this was a case of inexperience only. He thought that every installation set up ought to be overhauled. He agreed that all joints ought to be soldered; this was certainly not looked after in the earlier installations. The connections to cut-outs ought to be soldered.

Mr. J. VERITY said he had no direct point to criticise. He considered that there ought to be a general discussion on the fire risk rules. They were actually in the hands of the fire insurance companies, and the latter do not agree among themselves. He thought Mr. Heaphy would do a great service if he would undertake to bring about an agreement between all the insurance companies.

Mr. MANVILLE made a few remarks.

Mr. R. E. CROMPTON thought that if he were in Mr. Heaphy's position he would certainly consider that he was entirely justified in copyrighting his rules; the weakest would have to go to the wall, and this would not be Mr. Heaphy. He certainly did not think that fire offices would like to have their own rules merged into those of others when they had borne the brunt of the fight. Mr. Heaphy had therefore a justification for the position he had taken up.

Mr. A. SIEMENS considered that the great defect in Mr. Heaphy's rules was their uncertainness; they were all right if a conscientious inspector carried them out, but not otherwise. He recollected the circumstance of the disagreement in committee, and to a great extent sympathised with Mr. Heaphy.

The discussion then adjourned till May 17th.

STUDENTS' MEETING, MAY 3RD, 1888.

Mr. W. M. MORDEY in the chair.

Mr. E. J. RYVES read a paper on "Electric Welding," of which the following is an abstract:—

Some attention has lately been drawn to the subject of welding by means of electricity. In America Prof. E. Thomson has designed, and has, I believe, in working order, a system of electric welding which has the merit of simplicity as well as compactness. He uses an exceedingly heavy current at a low potential, and his method of obtaining it is by means of a transformer, by the use of which he can reduce the heavy current circuit to a foot or 18 inches in length, this making a large saving in copper as well as avoiding the great loss in conductors, from which it is so difficult to escape when using large currents. In this system an alternate current dynamo is connected to the primary coil of the transformer, while the secondary circuit is completed through the two pieces of metal to be united. The primary circuit of a welding set, with which I assisted in making some experiments not long ago, consisted of 30 yards of No. 16 B.W.G. cc. wire wound in a coil 6 inches in diameter, around which, and in the same plane, was bent a thick copper bar about 1½ inches in diameter, and which terminated in massive pole pieces which held the pieces of metal to be joined, these could be made to approach each other by means of a handscrew, so as to bring pressure to bear on the heated join. Both the primary and the secondary coils were completely covered by a quantity of iron wire. A good description of Prof. Thomson's apparatus appeared in the ELECTRICAL REVIEW of January 21st last year. We managed sometimes to obtain very fair welds, though the majority of the attempts we made were failures, due probably to want of experience; the joins looked very good from the outside, but were easily broken. The specimens which Prof. Forbes has kindly lent show, however, what can be done by this process. Another method of welding by means of electricity is that of M. Benardos, which I have had better opportunities of examining. Last summer I went to St. Petersburg for the purpose of seeing what his welding was like, and I am sorry to say that I was rather disappointed with what he could do; I unfortunately let him know this, which brought my visit to an end sooner than I intended as he would not show me anything more. On first entering his works I was shown specimens of welds done by his process which, as far as external appearances went, were perfect; some of these were a fair size, the area of join being in some cases 6 or 8 square inches. As I had not seen these made I could not bring them home as specimens of his process; but I had taken the precaution before I left London of having several pieces of wrought iron, mild steel, &c., cut for me in order that I might have them welded and afterwards tested; these were all stamped to prevent others being substituted for them. The current necessary for this process was derived from 150 Benardos accumulators, arranged in three parallel groups of 50 each, and which were charged at about 60 ampères for 10 hours a day. The dynamo was a shunt-wound Siemens's pattern, and was capable of giving a maximum output of 18,000 watts (150 volts 120 ampères), and was driven by a 25 horse-power steam engine. The total capacity of the battery was 360 ampère-hours at a potential of about 100 volts. The welding table consisted of a massive iron slab resting on wooden supports, and which was connected to the negative pole of the battery; the pieces of metal to be welded were laid on this table. A carbon rod varying from 13 mm. to 26 mm. in diameter (according to the size of weld to be made), and fixed in a suitable holder, was connected by a flexible cable to the other pole of the battery. The required temperature is obtained by starting the arc between the carbon rod and the metals to be joined, which are on the welding table. The current must have been very great, as there was seldom any resistance in circuit, and, except when welding small pieces of metal, four-fifths of his battery was switched on. The different experiments which were done for me included the welding of wrought iron to wrought iron, cast iron to cast iron, mild steel to mild steel, wrought iron to tool steel, drilling holes in iron and steel, &c.; none of these welds were really good, as the specimens on the table show. His method of going to work is briefly this: the ends of the metals to be joined are first of all melted down, then (if steel or wrought iron is being operated upon) pieces of wrought iron are placed on the join and melted in by the action of the arc; in welding cast iron or copper, the process is the same, except that cast iron and copper scraps are added respectively. When welding steel or iron, M. Benardos used a a mixture of sand and lime as a flux, when copper was one of the metals the flux used was borax. In nearly every case the metal was badly burnt and spoilt by the excessive heat, this seems to be unavoidable, and is the great fault in welds made by M. Benardos's process. In Prof. E. Thomson's method, of course, the temperature can be regulated to a nicety, and thus it has a great advantage over the other process.

Mr. MORDEY said the paper, although a record of failures, was not less interesting or useful on that account. He thought that many of the failures made by persons who had experimented with electric welding were probably due to the fact that they were not sufficiently acquainted with ordinary welding, in which perhaps they would not have been much more successful The amount of power used by M. Benardos was out of all proportion to the effect sought, and on this score the process of Prof. E. Thomson has a decided advantage. A probable application of the latter would be in heating and soldering—not welding—the joints of large conductors for street mains. He knew of no other means by which such an operation could readily be carried out. By this method it was possible to heat up a joint very quickly, and to localise the heat.

Mr. E. H. HUME drew attention to the fact that electric welding had been used some three or four years ago by Messrs. Siemens for jointing rails at Ryde pier.

After a few remarks from Messrs. MARSH and HAYNE, Mr. RYVES replied.

Specimens of Thomson's welds were lent by Prof. Forbes, to whom the thanks of the meeting are due.

A vote of thanks to the Chairman concluded the meeting.

Physical Society, May 12th, 1888.

Prof. REINOLD, F.R.S., president, in the chair.

Mr. G. L. Addenbrooke and Mr. H. A. Cumynghame were elected members of the society. The following papers were then read:—"Note on the condition of self-excitation in a dynamo machine," by Prof. S. P. THOMPSON, D.Sc. It is a well-known fact that a series dynamo running at a given speed will not excite itself, unless the resistance is less than a certain value depending on the speed and construction of the machine, and if the resistance is slightly less than this critical value the excitation will not be such as to saturate the magnets. According to the primitive statement of the action of self-exciting dynamos on the "compound interest law," a dynamo should excite itself to saturation at any finite speed providing the resistance is not infinite. An explanation of the observed facts is given in the paper without any assumption as to the curve of magnetisation. If E = E.M.F. of the machine n = speed, C = number of wires on outside of armature, N = number of magnetic lines, μ_1 = current, S = number of turns on magnet, ΣR and $\Sigma \rho$ the sums of the electric and magnetic resistances respectively, then $E = n C N$, $i = n C N/\Sigma R$, and $N = 4\pi S i/\Sigma \rho$. From these it is easily seen that $4\pi n C S = \Sigma \rho \Sigma R$, (A) *i.e.* for a dynamo running at constant speed, the product of the magnetic and electric resistances is constant, and the dynamo will not excite itself if ΣR is greater than $4\pi n C S/\Sigma \rho$. Similarly for a given value of ΣR, excitation is impossible if n is less than $\Sigma \rho \cdot \Sigma R/4\pi C S$. For a value of ΣR less than the critical value the excitation increases until the magnetic resistance is increased so that equation (A) is satisfied. The corresponding formula for shunt machines is $4\pi n C Z = \Sigma \rho \left\{ (r_a + r_s) + \frac{r_a r_s}{R} \right\}$ where Z = number of shunt turns, r_a, r_s and R, the resistances of armature, shunt, and external circuits respectively.

In the discussion which followed Mr. KAPP described a method used in testing dynamos for determining the minimum speed at which dynamos will excite themselves, and from thence determining the magnetic resistance of the air gap. In all cases experiment showed this to be less than the calculated resistance, generally in the proportion of 1,500 to 1,860, the difference being greater in low tension machines.

Prof. AYRTON pointed out that the permanent magnetism was not taken into account, and that the apparent resistance due to self-induction, and between the brushes and commutator were considerable for small currents.

Lord RAYLEIGH said Sir W. Thomson had shown critical speeds for given resistances to exist in Faraday's disc dynamos. He (Lord Rayleigh) did not approve of the term "magnetic resistance" and thought "reluctance" as recently suggested by Mr. Heaviside would be preferable.

"Note on the Conditions of Self-Regulation in a Constant Potential Dynamo Machine," by the same author. In "Dynamo Electric Machinery" a formula $\frac{z}{s} = \frac{r_s}{r_a \times r_m}$ is given as expressing the ratio of the numbers of turns in the shunt and series windings of a compound dynamo. This is on the assumption that there is no saturation within the working limits. As this assumption is not legitimate, a correcting factor is necessary. The factor is shown to be the ratio of the average permeability over the whole working range, to the permeability corresponding with no external current. The formula is transformed so as to be expressed in terms of the "natural" data of the machine, which, as shown in a previous paper, can be calculated from its details.

"On Magnetic Lag and the work lost due to the Magnetic Lag in Alternating Current Transformers," by Mr. THOMAS H. BLAKESLEY, M.A. The method adopted to detect the lag is to place dynamometers in both circuits, and one with a coil in each. Then, on the supposition that the E.M.F. of the secondary circuit is entirely due to the changing magnetism of the core, the author proves that the tangent of the magnetic lag angle must be equal to

$$\frac{\frac{m}{n} \text{C } a_3 - \text{B } a_2}{\frac{m}{n}\sqrt{(\text{A B } a_1 a_2 - \text{C}^2 a_3^2)}}$$

where m and n are the number of turns in the primary and secondary coils respectively, A, B, C the constants of the dynamometers, and a_1, a_2, a_3 their angular reading, A is such that $\text{A } a_1 = \frac{\text{I}_1^2}{2}$ where I_1 is the maximum value of the primary current. A table of actual results is given when the magnetic lag is about 5¼°. The whole power given out by the machine takes the form $r_1 \text{A } a_1 + r_2 \frac{m}{n} \text{C } a_3$ where r_1 r_2 are the resistances of the primary and secondary circuits, while the power lost in hysteresis is expressed by

$$r_2\left(\frac{m}{n} \text{C } a_3 - \text{B } a_2\right).$$

The lag is attributed to an induced magnetic stress called into being by the increasing or decreasing magnetism itself, and always opposing it, as motion in a medium induces an opposing force of friction. By supposing such an induced magnetic stress in quadrature (as Mr. Blakesley expresses it) with the magnetism, and of such a value as when compounded with the stresses due to the currents, shall bring the resultant into quadrature with the secondary current, the effective magnetic stress is obtained. This involves a new idea called magnetic self-induction, with its coefficient. The whole problem is treated by the geometrical method which the author has applied to several other problems in alternating currents.

Mr. KAPP, Profs. THOMPSON, PERRY and AYRTON and Lord RAYLEIGH took part in discussing the paper.

"On a Simple Apparatus for the Measurement of the Coefficient of Expansion by Heat," by Prof. W. E. AYRTON, F.R.S., and Prof. J. PERRY, F.R.S. The apparatus consists of a metal tube within which the wire or rod, whose coefficient is to be determined, is placed. One end of the wire is rigidly attached to one end of the tube, and the other end connected to an Ayrton and Perry magnifying spring, a pointer attached to which indicates the change of length due to alteration of temperature. Steam or water may be passed through the tube, the temperature of the wire being shown on a thermometer. The arrangement is very sensitive, and with a pointer about 20 cm. long the motion is magnified about 1,000 times.

A magnifying spring attached to an aneroid was also shown and its great sensibility demonstrated. A combination of a spring of large diameter and pitch, with one of small diameter and pitch, was exhibited. By such a combination small rotations can be immensely magnified. The great features of the patent spring as a magnifier are the entire absence of friction and back lash, and the large range of proportionality.

"A Note on the governors of Electromotors" by the same authors, and one "On the Electrical Action of Light," by Mr. W. E. AYRTON, were postponed until next meeting.

CORRESPONDENCE.

The Brooks Underground System.

I am duly grateful to Mr. David Brooks for his correction in your issue of May 4th, to my quotation from the respected "Josh Billings," whose writings Mr. Brooks has evidently studied with a greater zeal than he has devoted to the subject under discussion. With all submission I would maintain that although the quotation was not strictly accurate the inference holds good.

Your correspondent in giving free play to a rare vein of humour, has scarcely dealt fairly with the passage in which I refer to "overburdened brains." In fact, the whimsical tone adopted by him has probably been the cause, or perhaps indeed a means, of his omitting any reference to certain objections suggested by me as existing, not so much in the system he advocates, but in the method he employs, of trying to prove the excellence of that particular system.

Had Mr. Brooks chosen to deal at all seriously, that is from a technical or scientific basis, with the subject of underground conductors, some information might have been derived from, or some value attached to, his communications. I ventured to criticise Mr. Brooks's letter with the hope of obtaining some more reliable data on the subject of insulating conductors with rosin oil than is contained in his original paper; this he does not seem willing or able to afford, and instead, invests the question with so comic an element as to almost conceal the main points at issue. With regard to certain of my criticisms it is perfectly intelligible, however, that Mr. Brooks should show a want of appreciation.

From the general tone of Mr. Brooks's letter, I have evidently "struck oil," and however unsatisfactory his reply may be from a technical standpoint, one must admit that it is vastly amusing, and the readers of the ELECTRICAL REVIEW should be grateful to me for having, thanks to my humorous antagonist, provided so entertaining a discussion.

Underground.

P.S.—The undaunted Mr. Brooks means, I see from a postcript to his letter of May 4th, to "attend" to two other gentlemen who he complains have "kicked" him. I would beg these gentlemen, should they again tackle Mr. Brooks to treat him gently, bearing in mind that appeal to fairness often seen in the ball rooms of the cities in the Western States, "don't shoot the pianist, boys, he's doing his level best!"

Secondary Batteries.

The attention of my directors has been called to an anonymous letter in your issue of the 11th inst., and I am desired to express their surprise that a respectable journal like the ELECTRICAL REVIEW should insert an anonymous communication so partisan in character, malicious in intent, and untrue in fact.

Without discussing the question as to whether the letter is libellous or not, my directors feel sure that in future you will refrain from putting your columns at the disposal of persons whose aim, evidently from interested motives, is to give the public a false impression regarding the secondary batteries manufactured by this company, and by inuendo and misstatements to damage the property of its shareholders.

H. Dell, *Secretary,*
ELECTRICAL POWER STORAGE CO.

May 16th, 1888.

[We do not now think, neither did we at the time the letter complained of was inserted, that it contained anything likely to affect the interests of the Electrical Power Storage Company; and so far as the question of libel is concerned, Mr. Dell must surely be quietly poking fun at us. We have often considered the subject of anonymous correspondence, and there is much to be said for and against it. Nobody can deny that as much information may be gained from one who choses to use a *nom de plume* as from those who prefer to write under their own signatures; on the other hand, anonymous correspondence is sometimes used for unworthy purposes. We deal further with this matter in our other columns.—EDS. ELEC. REV.]

BRUSH.—The formula $c = a\,d^{\frac{3}{2}}$ means that d is to be *cubed*, then the *square root* of the result is to be taken, and finally the remainder is to be multiplied by a; thus, for example, if a is, say, 5172 and d is ·080, then ·080 cubed is ·000512 and the square root of ·000512 is ·022627, and finally, ·022627 multiplied by 5172 gives 117·0. The formula $d = \left(\frac{c}{a}\right)^{\frac{2}{3}}$ is the reverse of the foregoing, that is to say, in this case we must first divide c by a, then *square* the result, and finally take the *cube root* of the remainder.—EDS. ELEC. REV.

GOTT'S TEST.—The mistake to which $\text{J}\frac{\pi}{g^2}$ draws attention in Kempe's Handbook has been noticed by the author, and will be corrected in any future edition of the book; the formula should of course be $\text{F}_1 = \frac{\text{R}_2}{\text{R}_1}\text{F}_2$, as pointed out.—EDS. ELEC. REV.